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HISTOLOGICAL STUDY AND OBSERVATIONS ON THE EFFECTS OF SOME SYNTHETIC GROWTH SUBSTANCES ON STEM TIP CUTTINGS OF COFFEE [1]

POTENCIANO C. REAÑO

WITH FIVE PLATES AND ONE TEXT FIGURE

The effects on root development of plants of indole-3-acetic acid, indole-3-butyric acid, and various other substances were studied by Zimmerman and Hitchcock (1933), Cooper (1935), Zimmerman and Wilcoxon (1935), Zimmerman, Crocker, and Hitchcock (1933), Chadwick, (1939)[2] and Poesch (1938). Borthwick, Hamner, and Parker (1937) and Kraus, Brown, and Hamner (1936) studied histologically the effects of indoleacetic acid on decapitated portions of tomato plant, whereas Tincker (1937) dealt with the effects of β-indoleacetic acid and x-naphthalineacetic acid on the cambial activity and root production in woody cuttings.

The propagation of coffee by stem cuttings has been done with a certain degree of success (Miraflores, 1915; Briccio, 1933[3]). Although Gillet and Jackson (1937) observed stimulating effects of β-indole-acetic acid and other substances on coffee cuttings in South Africa, they did not make histological observations on them. In the present study are given results of field observations and histological data mostly on stem tip cuttings of *Coffea robusta* Linden treated with some synthetic plant hormones.

MATERIALS AND METHODS

Stem cuttings of *Coffea robusta* Linden were obtained from the College of Agriculture Coffee Plantation and Barrio San Antonio, Los Baños, Laguna, from April, 1938 to October, 1939. In the writer's trials, two types of cuttings were used; namely, the stem tip cutting and the portion back of it which henceforth will be referred

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[1] Experiment Station contribution No. 1361. Prepared in the Department of Agricultural Botany under the direction of Assistant Professor José B. Juliano.

[2] CHADWICK C. L. 1939. Synthetic growth substances. Mimeographed copy sent to the writer. 5 p.

[3] BRICCIO, R. S. 1933. A study of coffee propagation by cutting. (Thesis presented for graduation for the degree of Bachelor of Science in Agriculture, from the College of Agriculture, University of the Philippines. Unpublished).

to as advanced soft wood cutting. The latter consisted of mature portions of branches still green; the former was obtained from growing shoots bearing the actively growing points. Each cutting from both types had two to four mature leaves and was from fifteen to thirty centimeters long. The stem tip cuttings usually showed a chocolate-like, hard exudate from the protecting stipules to the growing point when they were taken from their mother plants. As soon as the cuttings were severed from the mother plants, their basal ends were cut obliquely and smoothly with a sharp budding knife and then they were placed for twenty-four hours in porcelain tumblers containing prepared solutions of synthetic plant hormones to a depth of two centimeters. After the treatment, they were removed from the solutions, and their leaves were cut in half, transversely. The basal portions were then rinsed in tap water before being planted in the propagating boxes or bed.

The chemicals used in this study were of three forms. The first were crystalline acids, namely, indole-3-propionic acid, γ-(indole-3)-n-butyric acid, indole-3-acetic acid, and phenylacetic acid, obtained from the Eastman Kodak Co., Rochester, New York, U. S. A. The second was "Hormodin A", a liquid preparation of Merck and Company, Inc., Rahway, New Jersey. The third, Rootone, obtained through the courtesy of Dr. Franklin Jones, horticulturist of the American Paint Company, Ambler, Pennsylvania.

Stock solutions were made by dissolving one gram of each acid in 125 milliliters of 95 per cent ethyl alcohol to which were added 125 milliliters of distilled water. Working solutions were prepared from these stock solutions by diluting them with desired amounts of distilled water.

"Hormodin A" working solutions were prepared according to the directions accompanying each bottle.

Rootone was used as it came in a porcelain container by simply dipping the basal ends of the cuttings in the dust, tapping them somewhat, and planting them direct in the propagating medium.

In the trials the cuttings were planted in propagating boxes containing the desired media. Later they were planted in a specially prepared propagating bed, 6 meters long and 3 meters wide. The soil was removed to a depth of forty-five centimeters and piled around the hole to a height of about fifteen centimeters in order to prevent run off water from entering the bed. The bottom of the hole was lined with fine sand five centimeters deep for drainage. On top of the sand a layer of pulverized garden soil, fifteen centimeters

deep was placed. The propagating bed was protected from rain and direct sunlight by a coconut leaf roofing supported by ipil-ipil [*Leucaena glauca* (Linn.), Gaertn.] posts and bamboo rafters. The shelter was made about thirty centimeters high at the edge of the bed and about one hundred fifty-two centimeters at the center so that rain water and diffused light could enter.

In planting, the treated and untreated cuttings were placed in the medium in a slanting position nine to fifteen centimeters apart each way. Then the soil around them was pressed down by hand and watered occasionally with tap water without saturating the medium.

Materials for histological study were obtained from the treated and control cuttings. Slabs were taken from the basal portions of the untreated and treated cuttings and were fixed and killed in formoacetic-alcohol prepared according to the formula of Chamberlain (1932). The fixed and killed material was softened in warm water (90°C.) for three hours. It was dehydrated in the usual way by being cleared in butyl alcohol (Zirkle, 1930) and embedded in paraffin. Sections 15 to 35 microns thick were cut and stained in either Heidenhain's haematoxylin with safranin, haematin and safranin or safranin-light green combination.

RESULTS AND DISCUSSION

Field observations

Preliminary trials, conducted from June 18, 1938 to September 18, 1938, showed that solutions of indolebutyric acid and indolepropionic acid containing as low as 10 milligrams to as high as 80 milligrams per 100 milliliters of distilled water were detrimental to the proper development of both green and stem tip cuttings of coffee. This was true whether or not the cuttings were provided with moist cheese cloth to prevent rapid transpiration during their growth in the propagating boxes. The medium was of equal proportions of peat moss and fine sand. These cuttings usually abscinded their petioles two days after planting, and on the fourth day were practically dead. When more dilute working solutions were tried; that is, those containing 0.04, 0.08, 0.4, 2.0, 4.0, and 8.0 milligrams, respectively, per 100 milliliters of distilled water, a greater percentage of survival and callusing was evident in cuttings treated with the first three working solutions. A much higher percentage of success was obtained when the propagating medium was made of equal propor-

tions of peat moss and fine sand. In these trials, a total of 1000 cuttings was used.

The detrimental effect of high concentrations of the acids caused softening and blackening of the bark at the basal ends of the cuttings, followed by the subsequent abscision of the petioles. Careful examinations of the dead cuttings revealed no fungous infection of the treated and untreated cuttings.

The results from several trial experiments indicated that the concentration conducive to the normal development of stem tip cuttings was around 0.04 to 0.4 milligram per 100 milliliters of distilled water in a propagating medium of equal proportions of peat moss and fine sand. If the cuttings were planted in sieved garden soil, a better percentage of success (as high as 38 per cent) was attained. Consequently, in the subsequent plantings, a medium of sieved garden soil was used for growing the cuttings after treatment.

Indoleacetic acid, indolepropionic acid, indolebutyric acid, and phenylacetic acid at concentrations ranging from 0.8 to 5.6 milligrams per 100 milliliters of distilled water were tried from January 22, 1939 to May 15, 1939. Indoleacetic acid gave the highest percentage of rooting comparatively at a concentration of 5.6 milligrams per 100 milliliters distilled water, followed by indolebutyric acid at the same concentration. The other substances were not as effective as these two acids, and their effective concentrations were somewhat variable. Indolepropionic acid was effective at a concentration of 2 milligrams per 100 milliliters of distilled water, whereas phenylacetic acid was most effective at a concentration of 4 milligrams per 100 milliliters. Among the treated cuttings some did not root at the time of digging on May 15, 1939, but their leaves remained green and callusing was evident.

In the last trial conducted from September 19, 1939 to December 23, 1939, indoleacetic acid was again found effective at a concentration ranging from 5.6 mg./100 ml. to 2 mg./100 ml. Indolebutyric acid and indolepropionic acid were effective at a concentration of 5.6 mg./100 ml., whereas phenylacetic acid was effective at a concentration of 4 mg./100 ml. The Rootone dust, which was used only at this time, was effective as far as rate of callusing was concerned, and the percentage of rooting was comparable only to that of indolepropionic acid at a favorable concentration. In the last two trials "Hormodin A" was effective at a concentration of 40 B.T.I.[4] All

[4] B. T. I.—Unit used by Boyce Thompson Institute.

treated cuttings showed decidedly more favorable results than the untreated ones, as these were dead when the cuttings were examined.

Poesch (1938) demonstrated that indolebutyric acid was the most effective of all the acids he tested on woody plants. He also stated that concentrations 1, 3, and 5 milligrams per 100 milliliters were effective on the rooting of woody ornamental plants if subjected to a 6 to 24 hour treatment. Gillet and Jackson (1937) in South Africa found that β-indole-acetic acid gave 78.6 per cent of rooting at a concentration of 1 part per 10,000 parts of water on *Coffea arabica* Linn. With Hortomone A (1 part in 150 parts of

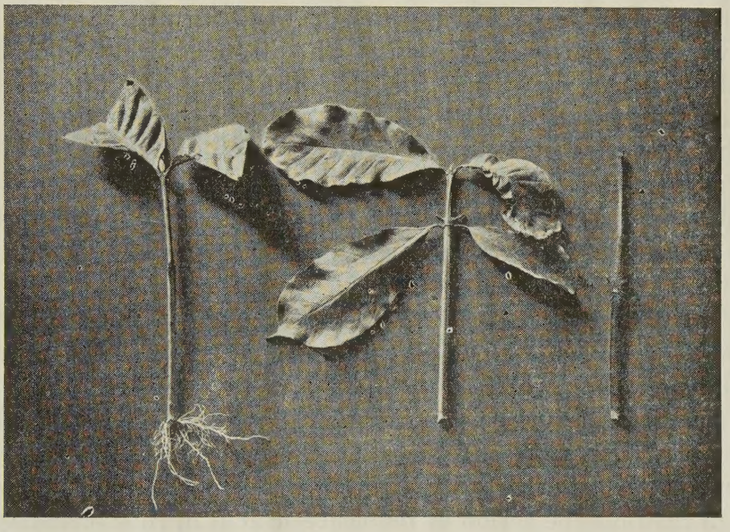

Fig. 1.—Responses of treated cuttings with half blade removed, blades intact, and all the blades trimmed off. Photographed November 14, 1939.

water), these authors obtained 92.9 per cent of rooting. Gillet and Jackson (1937) used bottom heat in propagating their cuttings. In the present investigation, the writer obtained as high as 80 per cent of rooting in indoleacetic acid, even if no bottom heat was applied. The writer further noted that if peat moss and sand would be used in the propagation of coffee stem tip cuttings, a much lower concentration of the acids would be necessary; thus the results of Gillet and Jackson (1937), who used the same medium, were corroborated. Indolebutyric acid had nearly the same effect in root formation as shown by their almost equal effectiveness in the rooting of the treated coffee stem tip cuttings.

In the Philippines often the leaves are removed in asexually reproducing some plants by cuttings perhaps because cuttings with leaves transpire more and consequently dry up more readily before they can strike roots. The writer observed that cuttings with leaf blades cut in half transversely and treated with 5.6 milligrams of indolebutyric acid per 100 milliliters of distilled water or any acid concentrations responded better than those with the entire leaf blades either removed or left on (fig. 1). All the cuttings with their blades removed died, and in some cases, rotting started at their distal ends, while callusing was evident at their basal portions. The basal portions of cuttings with entire leaf blades callused well, and some had root germs. These cuttings were planted again to determine whether they would root or not. After forty-six days from replanting, nearly all wilted, but out of the fifteen living specimens, ten had several root primordia, and one had roots already out. Roots of cuttings with half leaf blades were well developed forty-seven days from planting, whereas the rest rooted after ninety-three days from planting. The above results indicated that a part of the blade on the coffee stem tip cuttings had some influence on the formation of roots.

Went (1929) was able to extract certain substances from the leaf of *Acalypha*. When applied on the same species, it induced root formation. According to Cooper (1938), Went suggested that indoleacetic acid plays a dual rôle in root formation by first mobilizing rhizocaline, a root-forming substance discovered by Bouilenne and Went, 1933, and then reacting with it. Cooper (1938) demonstrated that in lemon cuttings the action of indoleacetic acid in root formation was primarily in the mobilization of naturally occurring root-forming substances in the leaves, one of which is necessary for the differentiation of root primordia, and one for the outgrowth of these primordia. The former substance appears more rapidly transported under the influence of the acid than the latter to the basal ends of the cuttings. Hitchcock and Zimmerman (1935) believed that synthetic growth substances when applied in water solution move longitudinally in the xylem, presumably in the transpiration stream, since their movement was influenced by transpiration the same as their absorption from the soil. Cooper (1935, 1936) experimentally proved that the root-forming substance in the leaves which are attracted by the growth substances applied at the basal ends of the cuttings moves downward in the phloem primarily in straight lines parallel to the phloem elements. According to the results of these investigators, cuttings with

entire blades on should respond better than those without any or with only half blades. It was noted, however, that cuttings of coffee with half blades rooted better and faster after treatment than those with either their blades intact or entirely removed.

Responses of coffee cuttings

Externally the first change observed after the applications of the acid was the appearance of a chocolate-like exudate from the growing apex of each cutting. Twenty-four hours after treatment the leaves showed signs of turgidity, and on the third day, a bump of callus was evident at the base of the cuttings. As the age advanced, these calluses often caused the cortex and epidermis of the cutting to rupture. On the fourteenth day bulging above the callus area just opposite the trimmed mature leaf and at a distance of five centimeters from the base was apparent. On the twenty-first day roots about 5.2 centimeters long appeared on the swollen portions above the callus area. These roots might emerge through the callus or a short distance above it. If the adventive roots emerged above the callus, they usually appeared at the sides where the stipules were borne. As the age advanced, the cuttings exhibited a rapid change of color from apple green to barium yellow,[5] and more gummy substances appeared on the terminal buds.

In all cases, the growth of roots preceded the development and growth of the terminal and axillary bud, but the growth of the former was always ahead of the latter. Some of the cuttings after striking roots were transferred to tin cans containing garden soil and one of those treated with indolebutyric acid (5.6 mg./100 ml.) flowered on January 8, 1940, exactly 261 days from planting in the bed.

Microscopical observations

Anatomy of the stem. The stem is rectangular in transverse section. On its periphery is a distinct layer of rectangular, thin-walled, epidermal cells, which have concave outer tangential walls (pl. 1, fig. 1). The continuity of the epidermal layer is broken at intervals by a few stomata. Beneath the epidermal layer is a rather thick cortex, which may be divided into three distinct regions. The outer region consists of two to five layers of small collenchymatous cells. Below this area are not more than thirteen layers of loosely arranged, oblong to nearly rounded parenchymatous cells, which

[5] In the determination of the color of the cuttings, RIDGWAY'S (1912) *Color Standards and Color Nomenclature* was used.

become large inward and leave between them large or small spaces. Beneath these cortical parenchyma and limiting the cortex inward are one to two layers of sclerenchyma (pericyclic fibers). Above these is a distinct row of cells, the starch sheath or endodermis. Beneath the pericyclic fibers is the phloem. This consists of thin-walled, parenchymatous cells, composed mainly of sieve tubes, companion cells, and parenchyma. Just below the phloem region are the two to five layers of rectangular cambial cells. The wood is rather thin, and the cells are all thick-walled. The protoxylems are located towards the pith, and secondary thickening has just commenced.

The pith is relatively large, occupying almost twice the area of the wood and bark grouped together. It consists of loosely arranged, rounded parenchyma, which have the tendency to be large towards the center. The cells are rounded to polygonal in a transverse section but more or less rectangular in a longitudinal direction.

Histological observations. The treated cuttings exhibited distinct formation of suberized layer (pl. 4, fig. 13) twenty-two hours after treatment, as is true of any type of cuttings (Sharples and Gunnery, 1933; Jimenez, 1937). The epidermis in both treated and untreated cuttings showed no activity at all and usually persisted as such if not killed by the more concentrated working solution of the hormones. Kraus, Brown, and Hamner (1936) observed that the epidermal cell of decapitated young bean plants underwent a few divisions in the radial plane and enlarged somewhat after treatment. During the growth of the cuttings, the epidermis was often destroyed within by the radial growth of the developing roots through the bark.

The first tissue of the cortex to exhibit marked activity was the endodermis (pl. 4, fig. 14) at some distance back from the cut surface. Kraus, Brown and Hamner (1936) observed that the endodermis of bean plant was one of those most responsive to indoleacetic acid. The cells divided tangentially once or twice; those near the cut surface often enlarged in all directions, but more so in the vertical direction, and thus formed a mass of tissue outside the pericyclic band of fibers. During this activity of a portion of the endodermis, several of the surrounding cortical cells might also become meristematic and actually contribute to the mass of cells derived primarily from the endodermis.

The development of oblong to elongated swellings, which attained a length of from 3 to 4 millimeters near the basal ends of treated

cuttings, was due to the enlargement and was perhaps accompanied by an increase in cell layers of the cortical cells below the epidermis (pl. 3, fig. 10 and 12; pl. 5, fig. 17). These cells lying in the interior usually enlarged in all directions, whereas those located toward the middle of the cortex enlarged mostly tangentially. Those situated nearer the epidermis underwent further divisions and enlargement, and this activity of the cortical cells increased considerably the enlargement of the swelling externally.

The phloem and cambial region usually became active. Tangential divisions followed at some distance from the cut surface but were much more pronounced near the cut (pl. 1, fig. 3); these pushed the cortex outward. Snow (1935) had also demonstrated a rapid cambial growth induced by an application of heteroauxin and urine at decapitated sunflower stem.

At times, the phloem and cortical area divided vertically, and the daughter cells proliferated on the cut surface, thus initiating the first callus pad (pl. 4, fig. 16).

The pericyclic fibers never become meristematic because they are sclerenchymatous.

The wood portion likewise was not activated at all and usually remained buried in the calluses formed from the phloem and cambium as well as from the pith (pl. 2, fig. 6).

The pith, like the other parenchymatous cells found elsewhere in the stem, also responded equally well, as had been observed by Kraus, Brown, and Hamner (1936) in decapitated bean plants. The cut pith cells usually died and became clogged with dirt and debris on their exposed portions. Those contiguous to the dead cells remained unchanged, but those lying interior were activated so as to form a continuous (pl. 1, fig. 4) or discontinuous (pl. 2, fig. 5) strip of meristem across the pith. This meristem varied from two to five layers thick. The development of a continuous meristematic strip across the pith sometimes did not take place; instead only patches were formed (pl. 2, fig. 5), where activity was most pronounced. Callus derived from the pith and that developed from the phloem, cambium, and cortex usually fused so as to cover the wound entirely at the basal end of the cuttings (pl. 2, fig. 6).

The untreated cuttings generally formed a callus, the origin of which was mainly from the phloem and cambial region (pl. 2, fig. 7 and 8). Generally the callus formed was not great and was belated in development.

Genesis of root. Root development was more pronounced on treated cuttings. The majority of the control cuttings died and exhibited only callus development, which was less marked than that of the treated cuttings. The second and third layers of the phloem cells just below the pericyclic fibers divided and enlarged tangentially (pl. 1, fig. 2) and served as the root initial. The cambial cells below this root initial also proceeded to divide tangentially, and enlargement followed; thus the mass of cells composing this root initial was considerably increased (pl. 5, fig. 18 and 20). The initiation of roots in treated cuttings seemed to be associated with the primary phloem and the cambial zone. Kraus, Brown, and Hamner (1936) found that adventive roots on decapitated bean stems treated with indoleacetic acid were derived from the secondary phloem. Likewise Borthwick, Hamner, and Parker (1937) demonstrated that the ring of adventive roots in decapitated tomato plants arose through the activity of the external phloem, whereas those developed in the pith were derived from the internal phloem and adjacent pith cells. Priestley and Swingle (1929) stated that in young stems the origin of root was the pericycle, whereas in older stems, the cambium. In either case the development of adventive roots was associated internally with the rays.

Soon after differentiation, the root primordia grew laterally, pushing the pericyclic fiber band (pl. 3, fig. 9 and 11; pl. 4, fig. 15) and the cortex (pl. 5, fig. 20) either horizontally or obliquely downward. In the former case the root emerged through the epidermis, whereas in the latter, through the callus.

SUMMARY AND CONCLUSIONS

1. Several synthetic growth substances were found to stimulate root development in stem tip cuttings of coffee.

2. Indole-3-acetic acid and γ-(indole-3)-n-butyric acid were the two most effective substances conducive to root formation in coffee stem tip cuttings at concentrations of from 4 to 5.6 milligrams per 100 milliliters of distilled water.

3. "Hormodin A" at a concentration of 40 B. T. I. was also effective in rooting stem tip cuttings of coffee.

4. Rootone dust could be used to a certain extent in the stimulation of roots of coffee stem tip cuttings.

5. Cuttings with half leaf blades removed twenty-four hours after treatment responded better than those with blades entirely removed or left intact on the cuttings.

6. Suberization of the cells from the treated cuttings took place twenty-two hours after treatment.

7. The epidermis of both treated and untreated cuttings showed no structural changes.

8. The endodermis was the first tissue of the cortex to exhibit marked activity, followed by the cortical parenchyma near it.

9. Of all the tissues activated, the phloem and the cambium were the most responsive, whereas the epidermis, wood, and pericycle were not activated at all.

10. The initiation of root primordia was associated with the phloem and cambium.

LITERATURE CITED

BORTHWICK, A. H., C. K. HAMNER, AND M. W. PARKER. 1937. Histological and microchemical studies of the reactions of tomato plants to indoleacetic acid. Both. Gaz. **98**: 491–519. *Fig. 1–20.*

BOUILLENNE, R., AND F. W. WENT. 1933. Recherches expérimentales sur la néoformation des racines dans les plantules et les boutures des plantes supérieures. Ann. Jard. Bot. Buitenzorg **43**: 25–202.

CHAMBERLAIN, C. J. 1932. Methods in plant histology. xiv + 416. 140 figs. Chicago: The University of Chicago Press.

COOPER, W. C. 1935. Hormones in relation to root formation on stem cuttings. Plant Physiology **10**: 789–794. *Fig. 1–4.*

COOPER, W. C. 1936. Transport of root-forming hormone in woody cuttings. Plant Physiology **11**: 779–793. *Fig. 1–8.*

COOPER, W. C. 1938. Hormones and root formation. Bot. Gaz. **99**: 399–614.

GILLET, S., AND T. H. JACKSON. 1937. The effect of growth substances on stimulation and growth of roots in cuttings of *Coffea arabica.* East African Agric. Jour. **2**: 76–83. *Fig. 1–2A.*

JIMENEZ, P. G. 1937. Callus and root formation in stem cuttings of kapok, achuete, and santol. The Philippine Agriculturist **26**: 585–635. *Pl. 1–13.*

HITCHCOCK, A. E., AND P. W. ZIMMERMAN. 1935. Absorption and movement of synthetic growth substances from soil as indicated by the responses of aërial parts. Contrib. Boyce Thompson Inst. **7**: 447–476. *Fig. 1–4.*

KRAUS, E. J., N. A. BROWN, AND K. C. HAMNER. 1936. Histological reactions of bean plants to indoleacetic acid. Bot. Gaz. **98**: 370–426. *Fig. 1–33.*

MIRAFLORES, J. C. 1915. Adaptability of certain Philippine plants to propagation by cuttings and marcottage. The Philippine Agriculturist and Forester **4**: 142–150.

POESCH, G. H. 1938. Effect of growth substances on the rooting of woody ornamental plants. Ohio Agric. Exper. Sta. Bimonthly Bull. **191**: 56–62.

PRIESTLEY, J. H., AND C. F. SWINGLE. 1929. Vegetative propagation from the standpoint of plant anatomy. U.S. Dept. Agric. Tech. Bull. 151: 1–99. *Pl. 1–24.*

SHARPLES, A., AND H. GUNNERY. 1933. Callus formation in *Hibiscus rosa-sinensis* and *Hevea brasiliensis* Muell.-Arg. Ann. Bot. **47**: 827–839. *Pl. 30–34.*

SNOW, R. 1935. Activation of cambial growth by pure hormone. New Phytol. **34**: 347–360. *Fig. 1–5.*

TINCKER, M. A. H. 1937. Growth substances, root production, and cambial activity in woody cuttings. Nature **139**: 1104–1105.

WENT, F. W. 1929. On a substance causing root formation. Proc. Kon. Akad. Wetensch. Amsterdam **32**: 35–39. *Fig. 1–2.*

ZIMMERMAN, P. W., AND A. E. HITCHCOCK. 1933. Initiation and stimulation of adventitious roots caused by unsaturated hydrocarbon. Contrib. Boyce Thompson Inst. **5**: 351–369. *Fig. 1–10.*

ZIMMERMAN, P. W., AND F. WILCOXON. 1935. Several chemical growth substances which cause initiation of roots and other responses in plants. Contrib. Boyce Thompson Inst. 7: 209–229. *Fig. 1–5.*

ZIMMERMAN, P. W., W. CROCKER, AND A. E. HITCHCOCK. 1935. The effect of carbon monoxide in plants. Contrib. Boyce Thompson Inst. **5**: 195–211. *Fig. 1–7.*

ZIRKLE, C. 1930. The use of n–butyl alcohol in dehydrating woody tissue for paraffin embedding. Science **71**: 103–104.

EXPLANATION OF PLATES

All photomicrographs were taken by the author in the Photographic Division, College of Agriculture.

PLATE 1

Fig. 1. Portion of a transverse section of coffee stem taken at the base of a cutting before treatment. × 92.

Fig. 2. Portion of a longitudinal section of the cuttings (15 days old) showing the initial activity of the outer two layers of phloem in the initiation of root primordium. × 400.

Fig. 3. Portion of the longitudinal sections of a cutting (17 days old) showing the activity of phloem and cambium. × 92.

Fig. 4. Portion of the longitudinal section of a cutting (2 days old) showing activity of the pith cells near the cut surface. × 92.

PLATE 2

Fig. 5. Portion of the longitudinal section of a cutting (14 days old) showing a patch of callus from the pith cells. × 92.

Fig. 6. Longitudinal section of a cutting (17 days old) showing calli derived from the phloem, cambium, and pith (right). × 92.

Fig. 7. Portion of the longitudinal section of an untreated cutting (36 days old) showing the development of the callus from both cambium and phloem. × 92.

Fig. 8. Ibid; much reduced. × 46.

PLATE 3

Fig. 9. Portion of longitudinal section of a treated cutting (14 days old) showing the root primordium. × 46.

Fig. 10. Showing enlargement of cortical cells from a cutting (50 days old). × 46.

Fig. 11. A much developed root initial from a cutting 36 days old. × 46.

Fig. 12. A more detailed view of a portion of the cortex from fig. 10. × 46.

PLATE 4

Fig. 13. Pith cells from a cutting (22 hours after treatment). × 400.

Fig. 14. Portion of longitudinal section of a cutting (3 days old) showing the activity of the endodermis. × 400.

Fig. 15. Root initial from a cutting (14 days old) pushing out the pericyclic fibers. × 46.

Fig. 16. Callus derived from the phloem, cambium, and endodermis, found in a treated cutting (3 days old). × 92.

PLATE 5

Fig. 17. Early stage in the activity of the cortex (cuttings 50 days old). × 46.

Fig. 18. Another root primordium pushing the pericyclic fiber (cutting 42 days old). × 46.

Fig. 19. Portion of longitudinal section of a cutting showing undifferentiated root primordium. × 92.

Fig. 20. A differentiated root primordium (cutting 50 days old). × 92.

PLATE 1

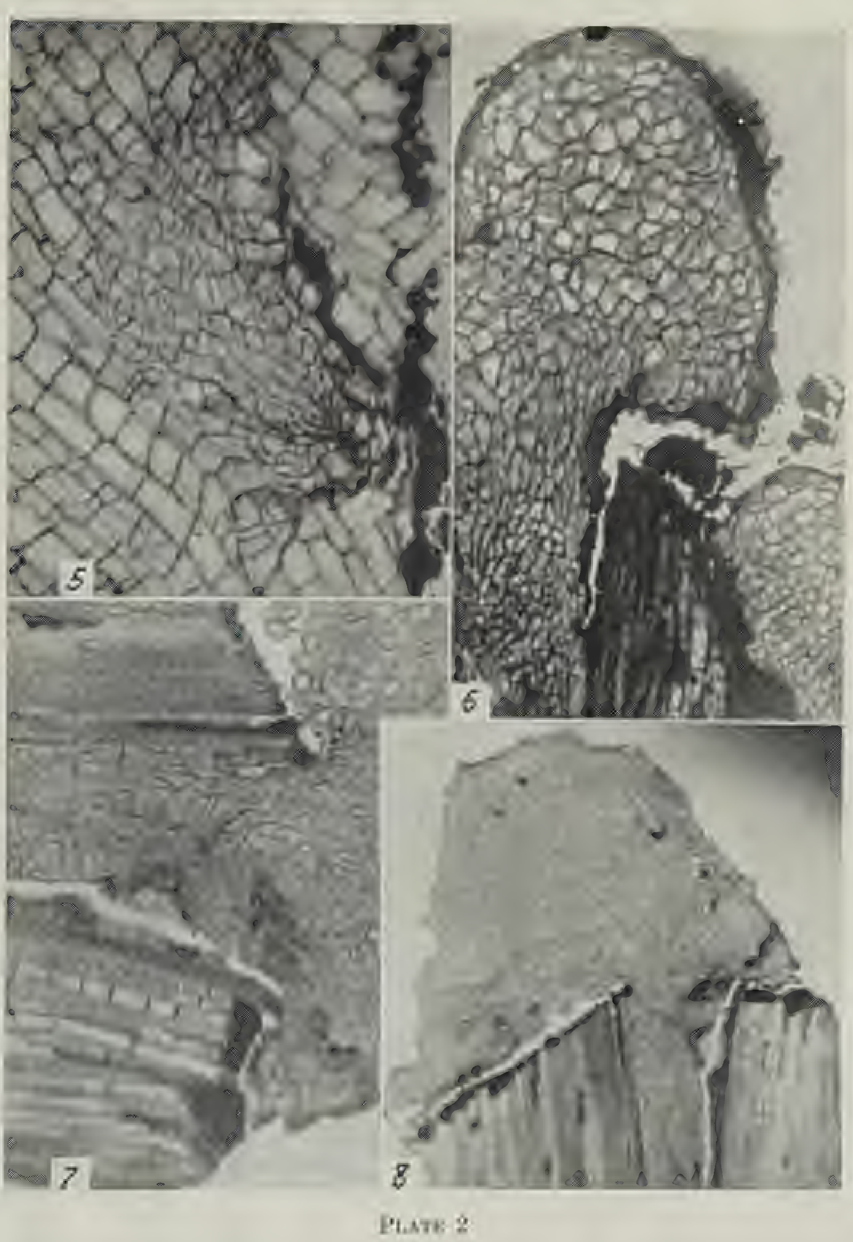

PLATE 2

PLATE 3

PLATE 4

PLATE 2

THE FERTILITY OF THE DUCK EGG [1]

F. M. FRONDA, L. P. ZIÁLCITA, AND AMANDO M. DALISAY [2]
Of the Department of Animal Husbandry

WITH SIX CHARTS

One of the most important commercial products of the duck industry in the Philippines is the *balut*. In the production of *balut*, a high degree of fertility among the eggs used is essential. Local duck raisers generally allow one male to every ten laying ducks, and with this ratio, the *balut* producers report a fairly high percentage of fertility among the eggs produced. Inasmuch as twenty-five or even thirty layers among chickens have been used with satisfactory results, is it possible to increase the number of laying ducks to a drake and still get profitable fertility in the eggs produced? If so, duck eggs could be more economically produced than at present.

Review of literature

In a popular article published in 1922, Stabottle [3] reported that the recommended ratio of male to female ducks is one to ten, and the percentage of fertility is about ninety. Burgos (1924) stated, however, that "it is believed that fertility of eggs could be increased by reducing the proportion of males to females to 1:6 or 1:8, instead of 1:9; or by using young active and vigorous ducks." He also reported that where the proportion of males to females was 5 to 20, the percentage infertility of the eggs obtained was 8.75 and 9.32 in two observations with Native ducks, and 42.00 and 13.22 with Indian Runners.

Fortier (1916) reported that one male is sufficient for four to eight females. He said that "when there are too many males in a flock at mating time, they quarrel and the eggs are not properly fertilized." Thompson (1922) recommended for optimum fertility one drake to every five or six females. He further stated that breeding ducks can be carried on in flocks of about thirty, since drakes rarely fight or bother each other. Lee (1927) advised that one drake be

[1] Experiment Station contribution No. 1362.
[2] Now fellow of the University of the Philippines in the United States.
[3] STABOTTLE, JEFFERSON D. 1922. Gentlemen, let us consider the balut. The Philippines Herald, August 27, 1922.
Read before the Los Baños Biological Club, June 27, 1940.

provided for every five ducks during cold weather, and seven or eight ducks for every drake during warm weather. He also stated that on large duck farms, 100 or more ducks are sometimes mated in a pen.

Objects of the present study

The objects of the present study were: (*a*) To determine the effects on the fertility of the eggs of allowing different numbers of female ducks to every male, and (*b*) to find out how long the eggs may remain fertile after the withdrawal of the males from the flocks.

These studies were conducted in the Department of Animal Husbandry from March to October, 1938.

PLAN OF THE STUDY

In this study, 225 Native ducks in their first laying year were used. They were divided into lots of fifty birds each except lot I, which had only twenty-five. The number of males placed in each lot was as follows:

Lot	*Number of ducks*	*Number of drakes*
I	25	1
II	50	2
III	50	3
IV	50	4
V	50	5

The ducks were given a ration containing 52.5 parts by weight of rice bran, 17.5 parts of ground corn (ratio of rice bran to ground corn being 3 to 1), and 30 parts of fish meal. To every 100 kilograms of this feed mixture, one kilogram of common table salt and two kilograms of ground shell were added. As much chopped green grass as the birds could take in one feeding was given to each lot morning and afternoon. The methods used in feeding and management were similar to those described by Fronda and Mencias (1937).

The tests

Three tests were made in this study. Before each test was begun, the eggs produced by the different lots were tested and ascertained to be infertile. These tests were done on the following dates: In the first test, the drakes were placed in the different lots on March 30, 1938, at 4 o'clock in the afternoon and they were removed on May 8 at 6 o'clock in the morning, a period of 38 days and 14 hours. The drakes were removed from the different pens when the fertility of the eggs produced during the previous ten days remained practically

at the same level. In the second test, after it was seen that no more fertile eggs were produced in the different lots for at least ten days, another set of drakes were again placed in the pens on June 1, this time at 6 o'clock in the morning. The drakes remained in the pens until July 12, when they were removed at 6 o'clock in the morning, a period of 41 days. For the third test, a different set of drakes were used and put in the pens on August 2, also at 6 o'clock in the morning. This last set of drakes remained in the pens up to 6 o'clock in the morning of September 9, a period of 38 days. Eggs were collected for fertility tests from the different pens up to October 2, 1938, or twenty-three days after the removal of the drakes from the pens.

RESULTS AND DISCUSSION

The results obtained in these studies are given in tables 1 and 2 and illustrated in charts 1a, 1b, 1c, and 2a, 2b, and 2c.

How soon may fertile eggs be collected from the flock? In the first test, when the drakes were placed in the pens at 4 o'clock in the afternoon, of the eggs collected the following morning, those produced by lots I, II, and IV were all infertile, whereas 6.8 per cent of those produced by lot III and 92.1 per cent by lot V were fertile. On the second day, after the drakes had been placed in the pens, all lots but II produced fertile eggs; lot I produced 7.8 per cent; lot III, 3.5 per cent; lot IV, 20.8 per cent; and lot V, 81.2 per cent. Lot II did not produce fertile eggs until the fifth day after the drakes had been placed in the pens. Then 4.6 per cent of the eggs produced were fertile. At this time, eggs produced by lot I were 22.2 per cent fertile; those of lot III, 12.5 per cent; those of lot IV, 32.5 per cent; and of lot V, 84.4 per cent. If a fertility of 80 per cent or over is considered the standard, it may be said that a profitable fertility was obtained from lot I on the sixteenth day after the drakes were put in the pens. The fertility of the eggs produced was then 83.3 per cent. Lot II took twenty-four days to produce a fertility of 80.3 per cent; lot III, eighteen days for 82.5 per cent; lot IV, twenty days for 80.0 per cent, and lot V, only one day for 91.1 per cent.

In the subsequent test, when the drakes were placed in the pens at 6 o'clock in the morning, no fertile eggs were produced in any of the pens on the first day. Unlike the first test, fertile eggs were produced on the second day in all pens. Thus in lot I, a fertility of 9.0 per cent was observed; in lot II, 20.0 per cent; in lot III, 33.3 per cent; in lot IV, 32.0 per cent; and in lot V, 30.7 per cent. In all lots,

a fairly high percentage of fertility of the eggs was observed on the third day. With a fertility of eighty per cent as a standard, in this test the ducks in the different pens produced eggs with profitable fertility in a shorter time than in the other tests. In lot I, 80.0 per cent fertility was produced on the fourteenth day after the introduction of the drakes into the pens; in lot II, on the twelfth; in lot III, on the tenth; in lot IV, on the sixth; and in lot V, on the fourth.

The variations observed in the results obtained in the first and second tests may be ascribed to the differences in the sexual activity of the drakes used. Probably the drakes in the second test were more active than those in the first. The more drakes that were in the pens, however, the sooner a profitable fertility was obtained from the eggs produced. From these results it may be stated that, other things being equal, when the ratio of drakes to ducks is 1:25 or 2:50 or 3:50, a profitable fertility of the eggs produced may be had after the second week of mating; whereas, when the ratio is either 4:50 or 5:50, a profitable fertility may be had after the first week the drakes have been put in the pens. With the latter ratio, a profitable fertility was obtained as soon as the second day.

Fertility as affected by the number of drakes in the pen. The fertility of the eggs produced by the different pens containing different number of drakes are given in table 1 and graphically represented in charts 1a, 1b, and 1c. These figures represent the averages of the three mating tests. From these, it may be seen that the fertility of the eggs produced by lot V was uniformly high from the beginning to the end of the test, whereas that of lot I was lower than any of the other lots. Also where more drakes were in the pens, a higher percentage of fertility was obtained during the first two weeks. After this period, however, the fertility of the eggs in all lots, except I, was more or less similar. These differences in the fertility of the eggs produced by the different pens are clearly shown by the charts.

In chart 1a, lot I (ratio 1:25) was compared with lot II (ratio 2:50), with lot V (ratio 5:50) used as the standard. The percentage fertility of the eggs produced by these two lots was practically the same up to the seventeenth day, when that of lot I began to decline and that of lot II was maintained and even increased towards the end of the period of observation. Probably the single drake in lot I had become impotent in the later half of the period. This may have been due to sexual over-activity during the earlier period. The fertility of the eggs produced by lot V was very much higher

than those of either lots I or II from the first day after the drakes had been put in the pens.

In chart 1b, lot II (ratio 2:50) was compared with lot III (ratio 3:50), also with lot V (ratio 5:50) as the standard. This chart shows that the percentage fertility of the eggs produced by lot III was higher during the first half of the period of observation than that of lot II; during the latter half, however, it was practically the same in the two lots. Here again, the percentage fertility of the eggs produced by lot V was also higher than those of either lots II or III. This indicates that the smaller the ratio of males to females, the higher the fertility of the eggs produced. Apparently for

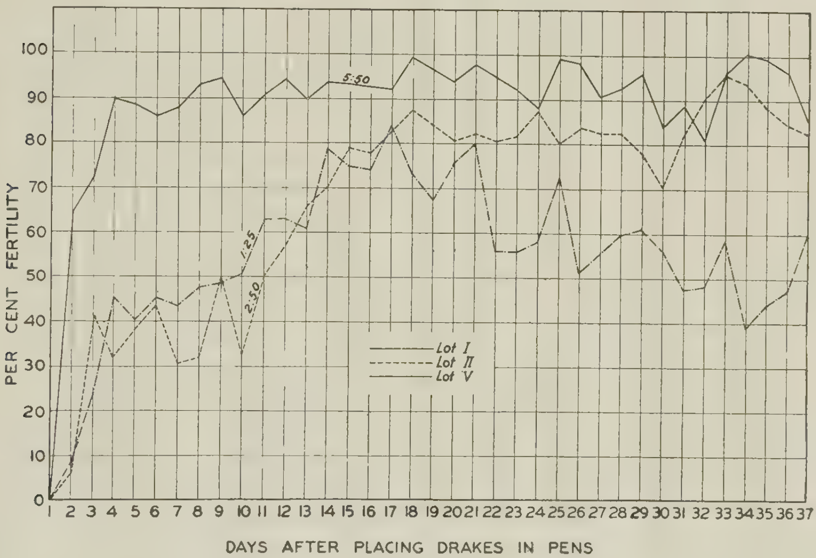

Chart 1a.—Fertility of eggs produced by lots I (1:25), II (2:50), and V (5:50) after placing drakes in pens.

the production of fertile eggs, the ratio of 3:50 is slightly better than that of 2:50, in a flock of 50 laying ducks.

In chart 1c, lot III (ratio 3:50) was compared with lot IV (ratio 4:50), with lot V (ratio 5:50) as the standard. This chart shows that the percentage fertility of the eggs produced by lot IV (ratio 4:50) is intermediate between that of lot III (ratio 3:50) and lot V (ratio 5:50). The percentage fertility of the eggs produced by lot IV was higher than that produced by lot III during the first week after the drakes had been put in the pens. After this period, however, it was practically the same in both lots, with lot

IV slightly higher towards the end of the period of observation. Here, again, the percentage fertility of the eggs produced by lot V was significantly higher than by lots III and IV.

The results obtained in this study definitely show that of the different ratios of drakes to laying ducks studied, the ratio 5:50 produced the most fertile eggs; 4:50, the second; 3:50, the third; 2:50, the fourth; and 1:25 the least. If a fertility of 80.0 per cent is considered as a standard, where the proportion of drakes to laying ducks is 5:50, the eggs may be considered highly fertile on the fourth day after the introduction of the drakes. Where the pro-

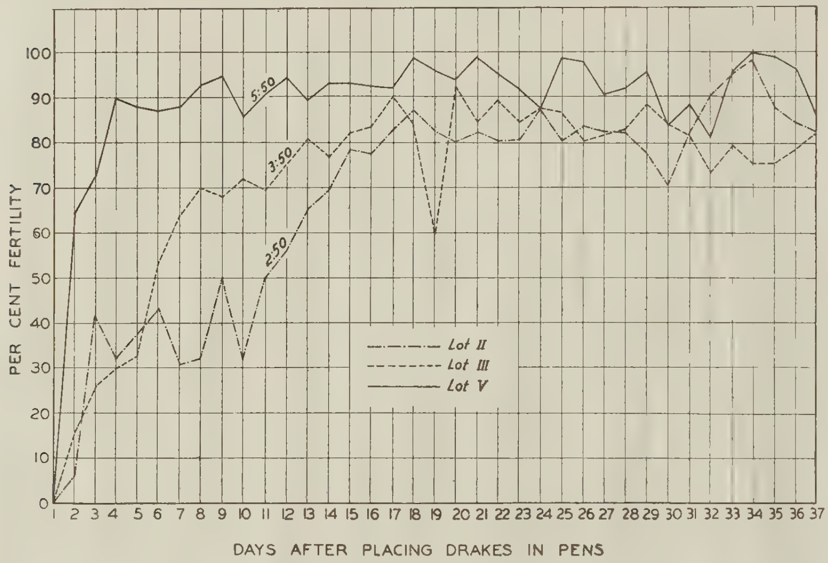

Chart 1b.—Fertility of eggs produced by lots II (2:50), III (3:50), and V (5:50) after placing drakes in pens.

portion is either 4:50, about twelve days are needed for the eggs to become about 80.0 per cent fertile, and seventeen days where the proportion is either 2:50 or 1:25. In other words, as the ratio of drakes to ducks increased, a faster rate was obtained towards an optimum fertility of the eggs produced by each lot. This can be easily seen in the varying slopes of the curves shown in charts 1a to 1c.

The fertility of the eggs produced by lot V was uniformly high from the fourth day till the close of the period of observation, whereas in lot I, the fertility was rather irregular. From a comparison of the percentage fertility of the different lots on the fifth

day, for instance, lot I was found to have a mean of 40.1 per cent and a standard deviation of 17.90; lot II, 37.9 per cent and a standard deviation of 32.24; lot III, 33.0 per cent and a standard deviation of 28.68; lot IV, 61.4 per cent and a standard deviation of 20.44; and lot V, 88.3 per cent and a standard deviation of only 5.12. On the tenth day, the standard deviations of the means of the different lots were observed to be 8.55 in lot I, 15.12 in lot II, 19.73 in lot III, 15.09 in lot IV, and 2.11 in lot V. On the twentieth day after the introduction of the drakes, the standard deviations of the means of the fertility of the eggs produced in the different lots were observed

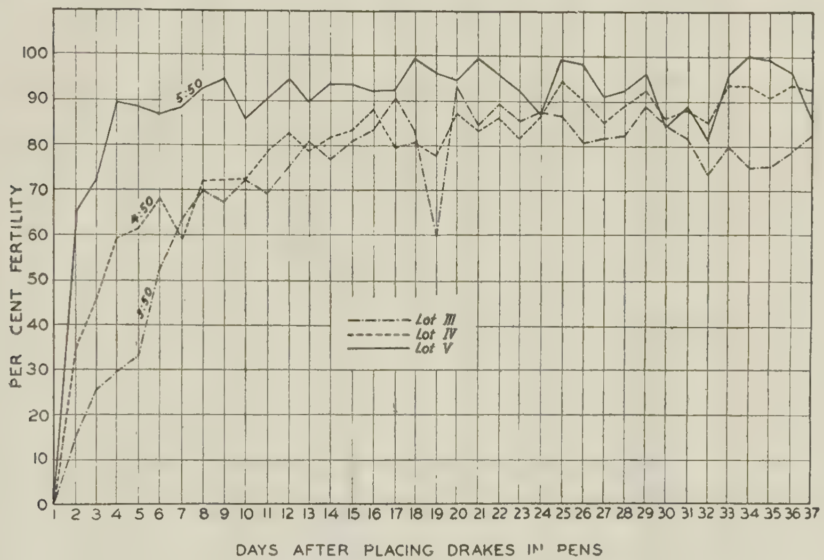

Chart 1c.—Fertility of eggs produced by lots III (3:50), IV (4:50), and V (5:50) after placing drakes in pens.

to be fairly low in all lots except lot I where the standard deviation of the mean was 29.41. On the twenty-fifth day, all lots had means of fairly low standard deviations; but on the thirtieth day, lot I again, had a high standard deviation, 26.65, whereas all the others had a low one.

Fertility of the eggs after the removal of the drakes from the pens. The percentage fertility of the eggs produced by the different lots as affected by the removal of the drakes is given in table 2 and illustrated in charts 2a, 2b, and 2c. Table 2 shows that the different lots had varying percentages of fertility, from 63.3 in lot I to 77.8 in lot III, one day after the drakes had been taken from the pens. The

fertility of the eggs in all lots tended to become lower as more days elapsed from the removal of the drakes; the rate, however, as illustrated in charts 2a to 2c was not always negative. In all lots the decrease in fertility was irregular, although as mentioned, the downward trend was unmistakable.

With the exception of lot III, all lots ceased to produce fertile eggs after the twelfth day from the removal of the drakes from the pens. Lot III continued to produce fertile eggs until the thirteenth day, 3.1

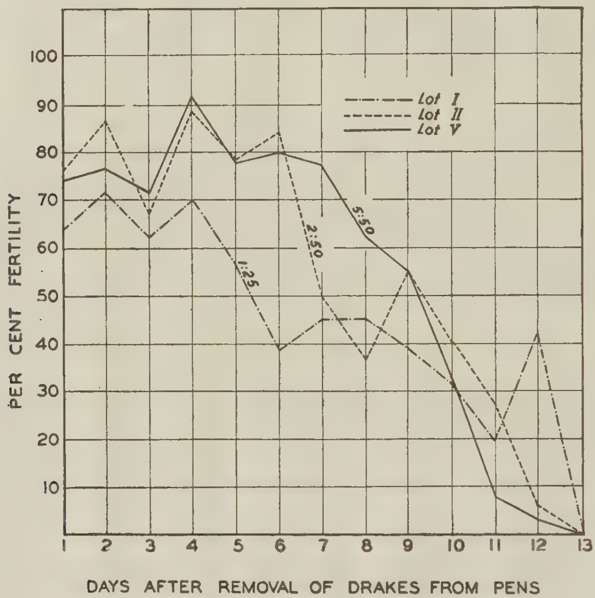

Chart 2a.—Fertility of eggs produced by lots I (1:25), II (2:50), and V (5:50) after removing drakes from pens.

per cent, after which no fertile eggs were further obtained in any lot. Tests were carried on to verify the infertility of the eggs produced by all the lots up to the twenty-third day from the removal of the drakes from the pens.

Chart 2a is a comparison of lots I and II, with lot V as a standard. From this, we can see that lot I had a lower fertility than lots II and V, with a single marked departure, which occurred on the twelfth day after the removal of the drakes from the pens. On this day, lot I had a percentage fertility of 42.2, which was considerably higher than any of the other lots. As mentioned before, lot I had a lower fertility of the eggs produced throughout the period of the studies;

this was attributed to the fact that only one drake was used. Despite the lower fertility of lot I, however, fertile eggs were present up to the twelfth day as was true of the other lots; furthermore, the rate of decrease of fertility approached that of the others too.

Chart 2b compares lots II and III. Lot V appears as a basis for comparison of these lots with the others not shown in the chart. It seems strange that despite the fact that lot III had in general a lower fertility than lot II up to the eleventh day, the rate of decrease of fertility was about the same. This would tend to show that the de-

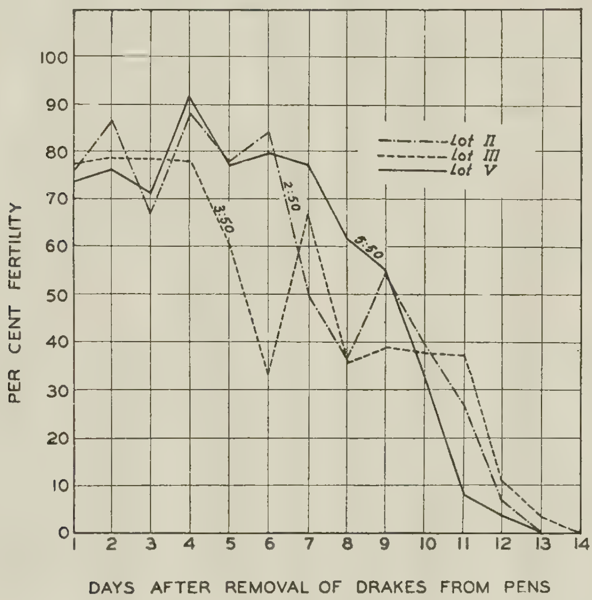

Chart 2b.—Fertility of eggs produced by lots II (2:50), III (3:50), and V (5:50) after removing drakes from pens.

crease of fertility of the eggs produced by the different lots after the removal of the drakes was unaffected by the number of males to females present in each lot. From this chart we also notice that unlike all other lots, lot III produced fertile eggs up to the thirteenth day after the drakes had been removed.

Chart 2c illustrates a comparison of the fertility of the eggs produced by lots III and IV after the removal of the drakes, with lot V as a standard. From this chart the fertility obtained in lot IV is seen to be higher than that in lot III, except during the later days, and approached closest the fertility of the eggs produced by lot V.

In table 2 it is apparent that the ratio of males to females in the different lots did not affect the decrease in fertility of the eggs produced, as days elapsed since the removal of the drakes from the pens. This is indicated in the various rates of decrease as shown in charts 2a to 2c, and especially by the fact that nearly all lots except III ceased to produce fertile eggs after the twelfth day.

If a fertility of eighty per cent is considered profitable, lots I and III did not produce eggs with profitable fertility after the drakes had been removed from the pens. Lot II produced fertile eggs up

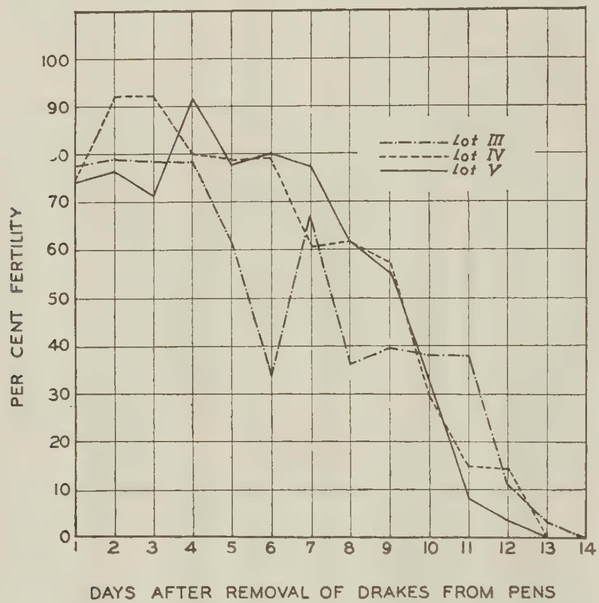

Chart 2c.—Fertility of eggs produced by lots III (3:50), IV (4:50), and V (5:50) after removing drakes from pens.

to the sixth day; lot IV, to the fourth; and lot V, to the sixth. In general, the results obtained from these studies show that eggs produced up to the fourth day after the removal of the drakes from the pens may be considered fertile to a more or less profitable degree.

SUMMARY AND CONCLUSIONS

The results obtained in these studies show that:

1. The greater the number of drakes allowed to a given number of laying ducks, the sooner a profitable fertility (80.0 per cent) may be obtained from the eggs produced.

2. Other things being equal, where the ratio of drakes to ducks is 1:25, 2:50, or 3:50, a profitable fertility of the eggs produced may be obtained after the second week after the drakes have been put in the pens, whereas where the ratio is 4:50 or 5:50, eggs for hatching may be collected profitably after the first week.

3. A higher fertility of the eggs produced was obtained as more drakes were allowed to a given number of ducks. Thus, the ratio 5:50 produced the most fertile eggs; 4:50, the second; 3:50, the third; 2:50, the fourth; and 1:25, the least.

4. The number of males to females apparently did not affect the rate of decrease of fertility of the eggs produced by the different lots after the removal of the drakes from the pens.

5. With the exception of lot III, all lots ceased to produce fertile eggs after the twelfth day from the removal of the drakes from the pens.

6. Eggs produced up to the fourth day after the removal of the drakes from the pens in general may be considered fertile to a profitable degree.

LITERATURE CITED

BURGOS, CARLOS X. 1924. The duck industry in the Philippines. P. I. Bur. Agric. Cir. 148: 1–15. *Pl. 1–4 fig. 1–3.*

FORTIER, VICTOR. 1916. Duck raising. Dominion Exper. Farms Exhib. Cir. 29: 1–4. *Fig. 1–2.*

FRONDA, F. M., AND LEON L. MENCIAS. 1937. The use of fish meal in duck rations for egg production. The Philippine Agriculturist **26**: 290–294.

LEE, ALFRED R. 1927. Duck raising. U. S. Dept. Agric. Farmers' Bull. 697: 1–22. *Fig. 1–15.*

THOMPSON, WILLARD C. 1922. Raising ducks and geese on New Jersey farms. New Jersey Agric. Exper. Sta. Hints to Poultrymen **10**: 1–4. *Fig. 1.*

TABLE 1

Fertility of the eggs produced by flocks of laying ducks provided with drakes in different ratios to females

DAYS AFTER PLACING DRAKES IN PENS	LOT I (1:25)	LOT II (2:50)	LOT III (3:50)	LOT IV (4:50)	LOT V (5:50)
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
1	0	0	0	0	0
2	8.4	6.3	15.3	34.8	64.3
3	23.3	41.5	25.8	46.6	72.7
4	45.0	31.8	29.7	59.5	89.9
5	40.1	37.9	33.0	61.4	88.3
6	45.3	43.5	52.2	68.1	86.9
7	43.1	30.4	63.1	59.1	87.7
8	47.3	32.0	69.9	71.9	92.9
9	48.1	49.0	67.3	72.3	94.6
10	50.2	32.0	72.3	72.7	85.9
11	62.7	49.8	69.2	78.8	90.4
12	63.0	55.8	75.0	82.9	94.5
13	60.8	65.2	81.0	79.0	89.6
14	78.2	69.6	76.8	81.7	93.5
15	74.6	78.6	81.9	83.4	93.1
16	74.0	77.5	83.7	88.0	92.1
17	83.7	82.3	90.5	79.7	92.5
18	73.0	87.3	84.3	80.8	99.3
19	67.1	84.3	59.9	77.8	96.3
20	75.2	80.8	93.0	87.6	94.4
21	81.1	82.9	84.9	83.3	99.1
22	56.1	80.9	89.2	86.2	95.4
23	55.7	81.8	85.3	81.9	92.2
24	58.3	87.3	87.9	86.3	87.8
25	72.8	80.4	86.8	94.5	99.2
26	51.6	83.9	80.6	90.3	98.1
27	55.2	82.7	81.8	84.9	90.8
28	59.9	82.6	82.2	89.1	92.4
29	60.8	77.8	88.8	92.3	96.1
30	56.1	70.5	84.4	86.0	84.1
31	47.6	82.3	81.7	88.3	88.8
32	48.3	90.0	73.8	85.2	81.0
33	58.7	95.1	79.8	93.4	95.4
34	38.6	93.1	75.3	93.6	100.0
35	44.0	88.4	75.5	90.2	99.1
36	47.1	84.4	78.8	93.4	96.3
37	59.1	82.4	82.2	92.6	85.1

TABLE 2

Fertility of the eggs produced by flocks of laying ducks after the drakes had been removed from the pens

DAYS AFTER REMOVAL OF DRAKES FROM PENS	LOT I (1:25)	LOT II (2:50)	LOT III (3:50)	LOT IV (4:50)	LOT V (5:50)
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
1	63.3	75.8	77.8	74.4	74.1
2	71.4	86.8	78.9	91.3	76.8
3	62.0	66.7	78.5	92.0	71.2
4	70.0	88.2	78.1	79.9	91.7
5	56.7	78.2	61.5	78.8	77.8
6	38.3	84.2	33.1	79.0	80.0
7	45.0	49.6	67.0	60.5	77.1
8	45.0	36.2	35.9	61.8	61.9
9	39.1	54.1	39.5	57.2	54.6
10	31.4	40.1	37.6	29.0	32.6
11	19.7	27.2	37.6	14.5	8.0
12	42.2	6.4	11.0	14.0	3.3
13	0	0	3.1	0	0
14	0	0	0	0	0

ANTHRACNOSE OF BLACK PEPPER (PIPER NIGRUM LINN.)[1]

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Of the Department of Plant Pathology

WITH FIVE TEXT FIGURES

Anthracnose is prevalent on black pepper (*Piper nigrum* Linn.). The disease occurs on the foliage and is associated with dead areas sufficiently large to interfere seriously with the functions of the leaves. Hitherto nothing has been known of the nature of the disease and the extent of the damage that it causes. Although black pepper has been grown in the Philippines for many years as a minor crop not much is known of its diseases.

THE DISEASE

Extent of damage to the plant

In the rainy days around Los Baños, anthracnose occasionally causes a serious infection and kills a proportion of the leaves of black pepper; thus the production of the plant is seriously affected. The infected plants are sometimes killed prematurely.

Symptoms

Early stage of infection. Anthracnose starts on any portion of the leaf. Very often the young leaf is more easily infected than the old. When young, the lesions are small, dark, and either circular or irregular and have a distinct yellow to light brown border (fig. 1.) They grow rapidly during cool and moist days.

Advanced stage of infection. As the lesions grow old, they turn darker and darker until they are almost black. They increase in size, and nearby spots merge together forming larger irregular dead areas. The infected areas are of varying sizes and shapes, and have a distinct, small, water soaked border. At this time, owing to the dropping off of the central dead tissues, holes are sometimes left in the center of the spots. During cool, moist, or rainy days, the infected areas rapidly increase in size and cause the seriously infected

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[1] Experiment Station contribution No. 1363. Prepared in the Department of Plant Pathology under the direction of Associate Professor G. O. Ocfemia.

leaves to drop to the ground and rot. Under field conditions, the disease frequently starts at the tip of the leaves, and causes this region to dry out. From there the disease progresses inward until about one-third to one-half of the leaf area is involved (fig. 3).

CAUSAL ORGANISM

Morphology

Mycelium. Young and old hyphae are septate, more or less coarse, hyaline to subhyaline, variable in size, and granular in con-

Fig. 1.—A young stage of infection produced in artificial inoculation of a young leaf of black pepper showing small dark brown to almost black spots which afterwards merge with other spots to form larger dead areas. Photograph by the Photographic Division, College of Agriculture.

tent. With age, the hyphae become compact and dark brown. The mycelium is simple when young but much branched when old (fig. 2.)

The mycelial cells are 7.0-24.5 μ in length and 3.5-8.7 μ in diameter; the average is 15.7 x 6.1 μ.

Conidiophores. The conidiophores are borne directly on the vegetative hyphae. They are simple, hyaline, and granular in content. Each conidiophore produces one conidium at the tip. As

soon as the conidium matures, it is detached, and the conidiophore produces a second one by simple abscission. The same process is followed in the production of the third, fourth, and other spores that

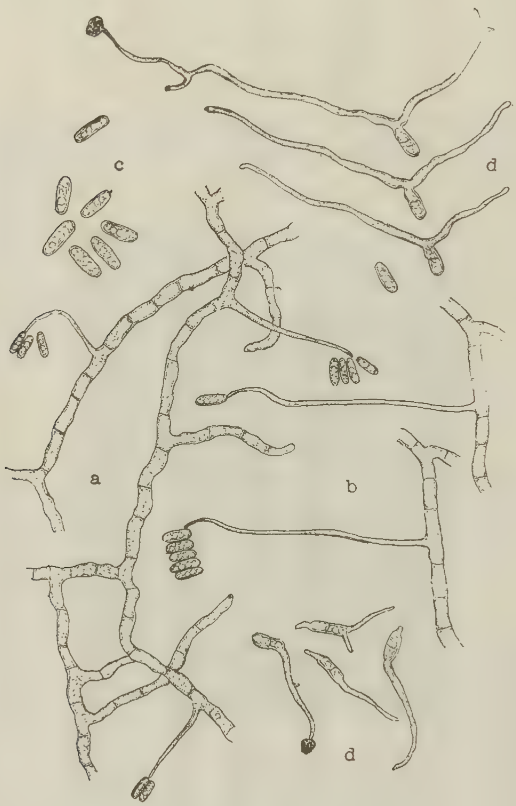

Fig. 2.—Camera lucida drawings made by the senior author showing: (*a*) mycelium of the *Gloeosporium* stage of *Glomerella cingulata* (Stonem.) S. and v.S. obtained from artificially inoculated leaves of black pepper; (*b*) a conidiophore of the fungus showing a group of conidia at the tip; (*c*) conidia taken from artificially infected leaves of black pepper; and (*d*) germinating conidia showing appressorium-like bodies at the end of the germ tubes. All drawings about 204 ×.

follow (fig. 2). The writers found that the number of conidia produced by each conidiophore varied from two to six or more.

The size of the conidiophores varies from 21.0-175.0 μ x 3.5-5.25 μ; the average size is 98.0 x 4.37 μ.

Conidia. The conidia are thin-walled, oblong-elliptical, rounded at the ends, and granular in content (fig. 2). Under the microscope, they are hyaline, but in mass, they appear pinkish.

The conidia are produced abundantly and germinate within twenty hours after being placed either on potato-dextrose agar or in water.

The sizes of the conidia in pure culture vary from 12.2-19.2 μ x 3.5-7.0 μ; the average is 15.7 x 5.2 μ.

Fig. 3.—Early and advanced stages of the disease on leaves of black pepper produced in artificial inoculation. Photograph by the Photographic Division, College of Agriculture.

During the course of the work, no spore stage other than the imperfect or asexual stage was produced by the fungus.

Ratio of length to width of conidia. Rosenbaum (1917) determined the ratios of length to width of the conidia of species of *Phytophthora*. This method was followed by Weston (1920, 1921) for *Sclerospora philippinensis* Weston and *Sclerospora spontanea* Weston, by Reinking (1923) for *Phytophthora faberi* Maubl., by Ocfemia and

Roldan (1927) for *Phytophthora faberi* Maubl., and by Ocfemia (1925) for *Phytophthora melongenae* K. Sawada. With the same method, the ratios of length to width of 100 conidia of the black pepper fungus were determined. These ratios were distributed in classes made by a difference of 0.25 μ as shown in table 1. Figure 4 shows a graphic presentation of the arrangement in classes of the ratio of length to width of 100 conidia. The figure also shows the limits of variation for the *Gloeosporium* of black pepper in the Philippines.

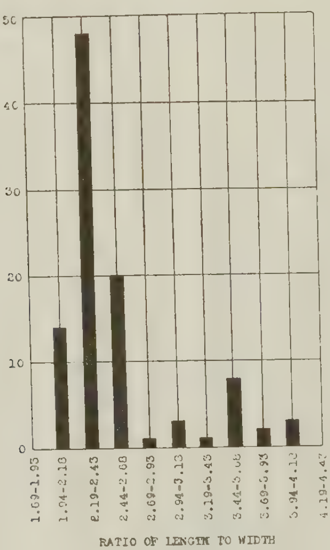

Fig. 4.—Ratios of lengths to widths of 100 conidia of the causal organism distributed in classes made by a difference of 0.25 micron.

Germination of conidia and methods of penetration. At germination the conidia become uniseptate. They produce either one germ tube at or near the end, or two germ tubes, one from each end (fig. 2). Later the germ tubes branch repeatedly and become mycelium. The mycelium gives rise to conidiophores that produce conidia by abscission. Appressorium-like, dark bodies are often produced at the branch tips of the germ tubes of germinating conidia.

Inoculation experiments have demonstrated that very little infection was obtained when uninjured leaves of black pepper were atomized with spore suspension of the fungus. Similarly infection

failed on avocado leaves which had been smeared with fungous growth on the upper surface. Infection was obtained however, on leaves which had been inoculated on the lower surface. These results suggest that the method of penetration by the germ tubes of the spores of the fungus is in the absence of wounds and other mechanical injuries probably stomatal.

Cultural studies

The growth of the *Gloeosporium* of black pepper was studied, with common media and sterilized plant tissues used.

The results from study of the growth of the fungus and the changes of color [2] of the mycelium and of the spores, rate of growth, production of conidia on different media, and substrates are summarized as follows:

Potato-dextrose agar. The fungus produced a very good growth on potato-dextrose agar. The white cottony aërial hyphae appeared sixteen hours after the transfer. The mycelium was produced thickly and profusely and covered the entire surface of the agar slant in four days. The color of the mycelium changed to rose gray after a few days of growth, sepia in the second week, and dark mouse gray in the fourth week. The fungus produced spores abundantly in forty-eight hours and masses of spores in five days. The masses of spores were first pinkish and moist; the color changed to mikado orange in the second week, iron gray in the third, and black at the beginning of the fourth week.

Oatmeal agar. It is strange that the fungus produced a very poor growth on oatmeal agar. The mycelium was scanty and took eight days to cover the entire surface of the agar. The white cottony aërial hyphae could be seen only along the border of the agar. The hyphae turned pale gull gray in nine to twelve days. A few spores were produced in four days, but an abundance of mikado orange masses of conidia appeared in eight days. The masses changed in color to ochraceous-salmon at the end of twenty-eight days.

Water agar. As expected, water agar was a very poor medium for this fungus; it was even poorer than oatmeal agar. The mycelium was very slow in its growth and took eleven days to cover the entire surface of the agar slant. It changed from cottony white

[2] The color names used in this study are those of RIDGWAY, ROBERT. 1912. Color standards and color nomenclature, 43 p., *53 colored pl.; 1115 named colors.* Washington, D. C.

to pallid mouse gray at the age of one month. Spores were produced on the fifth day. The pinkish masses of spores occurred at the age of seven days and turned capucine orange on the twentieth day.

Potato cylinder. The fungus started to grow on this substrate in less than sixteen hours. It produced a very good growth and spread very profusely. In six days the surface of the potato cylinder was entirely covered with the growth. Potato cylinder was one of the best substrates for this fungus. The cultures produced numerous conidia in fifty-two hours and an abundance of capucine yellow masses of spores in ten days. The mycelium was gray and dark olive gray, whereas the masses of spores were dark brown and almost black with age.

Sterilized sweet-potato plugs. The fungus exhibited a fairly good growth on sterilized sweet-potato plugs. The mycelium started to grow in less than sixteen hours. The growth was cottony white at first, but it became dark on the fifth day, light neutral gray on the ninth day, and deep olive gray in the fourth week. Countless conidia and numerous mikado orange spore-masses were noted on the fourth day. The masses of spores turned brown, gray, and almost black in twenty days.

Sterilized petioles of black pepper. On this substrate, the fungus grew well. It started to grow sixteen hours after the transfer and developed profusely. An abundance of mycelium covered the entire surface of the cylinder in about five days. The spores appeared in thirty-six hours, and orange pink masses of them developed abundantly along the sides. The tufts were orange pink and moist at first, but they became brown in sixteen days and later almost black.

Sterilized cabbage petioles. Sterilized cabbage petioles were a good substrate for the organism. An abundance of mycelium was produced after sixteen hours, and it covered the substrate in five days. The mycelium was cottony white at first, but later became seashell pink. A fair number of spores was produced in thirty-six hours. Masses of spores were noted on the sides and surface of the substrate on the fourth day. They were moist and orange chrome in color and later turned to xanthine orange and almost black at the end of one month. The organism produced profuse growth.

Sterilized sword beans (*Canavalia gladíata* [*Jacq.*] *DC.*). The organism grew very well on sterilized sword bean pods. The thick mycelium produced had numerous spores in thirty-six hours. It

easily covered the entire bean pod in three and a half days. The growth turned to pinkish cinnamon in a few days and became gray when old. Masses of spores, which were moist and orange in color when young, developed practically all over the pod on the fifth day. The spore masses turned gray to almost black with age.

Sterilized avocado cylinder. On the sterilized avocado cylinders, the fungus exhibited a fairly good growth. It produced thick mycelium which covered the entire substrate in six days. Spores were found on the third day. The fungus produced masses of conidia on the sixth day, which were ochraceous-salmon when young but darker with age.

Sterilized string bean pods. Sterilized stringbean pods seemed to be a good substrate for the fungus, which produced a profuse growth on it. An abundance of luxuriant mycelium covered the surface of the substrate on the sixth day and produced large quantities of spores in two days. The mycelium was white at first but gradually turned dark. Apricot orange colored masses of spores were abundant in the first week. In the fourth week, the mycelium turned gray, while the masses became almost black.

Sterilized eggplants. The fungus produced a good growth on sterilized eggplant fruits. The mycelium produced was thick and covered the cylinder in six days. A fairly large number of spores was found in three days. Masses of spores of pinkish cinnamon color were formed in five days.

Sterilized patola cylinder (*Luffa cylindrica* [*Linn.*] *M. Roem.*). Sterilized patola cylinder was a good substrate for the growth of the organism. An abundance of mycelium appeared in twenty-four hours, and the growth covered the substrate in six days. After four days, the mycelium turned darker with age. The masses of conidia, which formed in five days, were light pinkish cinnamon and moist in appearance. A fairly large number of spores was produced on the substrate in three days. The masses of spores became darker and at the end of the fourth week were almost black.

The results of the cultural studies show that the *Gloeosporium* on black pepper does not produce the same amount of growth on media and on substrates. Of the media used, potato-dextrose agar was best suited to the cultivation of the fungus, oatmeal agar was next, and water agar, the poorest. Of the sterilized plant tissues used as substrate, potato cylinder, sword bean, petiole of black pepper, and cab-

bage were the best; these were followed by sweet potato, string bean, eggplant, and patola. Avocado was the poorest among them.

On all culture media used in the present experiments, the conidia were produced in two to five days, and the masses of spores in five to ten days after the transfer. In general, the young and fresh masses of spores were moist and pinkish to orange. They gradually turned gray, brown, and almost black with age.

The fungus produced cottony white mycelium at first, but as the growth advanced, it turned dark or gray. No sexual stage of the fungus was noted on the media and substrata during the period of the cultural experiments.

Pathogenicity of the fungus

In order to determine the pathogenicity of the fungus, leaves of black pepper seedlings were inoculated with pure cultures of *Glomerella cingulata* in the laboratory. Three methods of inoculations were used: (1) the leaves were atomized with a suspension of conidia. The controls were sprayed with sterile water only; (2) the leaves were pricked and then (*a*) the spores and mycelium of the organism from the pure culture together with bits of potato-dextrose agar were smeared on them with a camel's hair brush, and (*b*) the leaves were atomized with suspended spores in sterile water. The controls were pricked also, but they were smeared with sterile potato-dextrose agar only; and (3) the leaves were smeared with spores and mycelium together with bits of potato-dextrose agar of the organism from pure culture without injuring the leaf tissues. The controls were smeared with sterile potato-dextrose agar.

All of the inoculated plants were kept either in the moist chamber or under bell jars for a sufficient period of time; after this they were placed outside in the shade. The inoculated and check plants were placed in damp chambers or under bell jars in order to handicap them, because when the fungus is in culture, it is growing in an abnormal condition.

Experiment 1. On November 19, 1938, six healthy black pepper seedlings grown in earthen pots containing sterilized garden soil were selected; four were used for inoculation, and the remaining two were used as controls. Five young leaves of each plant were carefully washed with sterile water and inoculated by atomizing them with a spore-suspension of the fungus. They were kept in the moist chamber for four days and afterwards placed outside in the shade.

On November 30, 1938, one of the inoculated plants showed symptoms of the disease, another was infected on December 2, 1938, whereas the rest remained uninfected. The infected plants, however, did not die. Only a few of the leaves showed infection under damp chamber conditions. The progress of the disease was practically checked when the plants were placed outside. The new leaves that appeared showed complete freedom from the disease.

Fig. 5.—Young leaves of the cultivated ikmo (*Piper betle* Linn.) showing the advanced stage of the disease produced in artificial inoculation. The seriously infected leaves drop to the ground and rot. Photograph by the Photographic Division, College of Agriculture.

The first symptoms shown on the leaves were small dark spots, irregular in shape (fig. 1). With age, they turned almost black and merged with neighboring spots, forming larger lesion (fig. 5).

The fungus was reisolated by the tissue culture method with small portions of the infected leaves. The culture obtained was purified by the spore-dilutions or single-spore strain method. The resulting cultures were used in subsequent inoculation experiments.

Experiment 2. On December 10, 1938, eight seedlings were inoculated by pricking the leaves of three and smearing on them spores and mycelium together with bits of potato-dextrose agar. Three other seedlings were atomized with a spore-suspension of the fungus after the leaves had been pricked. The remaining two seedlings served as controls. The inoculated and control plants were kept in the moist chamber for four days.

On December 14, 1938, the seedlings of which the leaves had been pricked and smeared with the fungus showed symptoms of infection on the injured area. Irregular dark areas were noted distinctly. They became grayish black and increased in size as the disease advanced in age. The seedlings whose leaves had been pricked and then sprayed showed small infected spots, irregular in shape and size. In the early stage of infection, the lesions were dark brown, but later turned almost black and increased in size. During rainy days, the infected areas enlarged rapidly, and the leaves rotted and dropped off easily. It was noted that under conditions prevailing in the open and even under partial shade, the disease was confined only to the leaves that became infected while the plants were in the damp chamber. That the fungus was very weakly parasitic on black pepper was shown by the fact that less than 20 per cent of the pricked areas in the leaves that had been smeared with the fungus showed infection even under humid situations in the inoculating chamber.

Experiment 3. On December 28, 1938, six black pepper seedlings were inoculated by smearing the uninjured leaves with spores and mycelium together with bits of the media. Three seedlings were used as controls. During the day, the plants were kept under bell jars in the laboratory, and during the night, in the moist chamber. This treatment lasted for six days.

Of the six inoculated plants, only four became infected on January 3, 1939. Small lesions were shown only by the inoculated young leaves. Mature and fully expanded leaves at the time of inoculation did not show the disease in spite of the heavy application of the inoculum on the upper and lower surfaces. The lesions produced in the young leaves were dark gray and had small, water-soaked borders. They increased in size with age, especially under humid conditions. The controls remained normal during the period of the experiment.

Experiment 4. During the period from the latter part of March 1939 to July, 1939, inoculation was performed on twenty-four

plants with larger masses of the organism. Eight plants were inoculated by atomizing the leaves with a spore suspension, eight by atomizing the leaves after pricking them, and another eight by smearing the fungus on the leaves to be inoculated. Six healthy plants were used as controls for the three methods of inoculation. The inoculated and checked plants were kept either in the moist chamber or bell jars in the laboratory in order to obtain favorable conditions for infection by the fungus.

The experimental plants were infected, except three of those which had been atomized with a spore suspension and two of those which had been smeared with pure culture of the fungus. The infection was limited, however, to the young immature leaves. As in previous inoculations none of the experimental plants died. The disease progressed very slowly after the plants were removed from the inoculating chamber. In most cases the young shoots that appeared later escaped infection by the fungus. The controls showed no infection at all throughout the period of the experiment.

The inoculated plants became diseased in a shorter period of time than those used in Experiment 1. During the rainy days, the size of the infected areas increased rapidly, and the leaves fell off.

In all inoculations the fungus was reisolated, and a pure culture of the organism was obtained.

Experiment 5. Leaves of chewing ikmo (*Piper betle* Linn.), wild ikmo plants (*Piper* sp.), and avocado seedlings were inoculated with the fungus during the months of July and August, 1939.

Except for the (*Piper betle,*) these plants were susceptible to infection with the disease only when the inoculum was applied on the young and immature leaves. The inoculated plants produced symptoms of the disease after one week in the moist chamber. The leaves of the wild ikmo plants, however, showed only a slight infection. On the other hand, the cultivated ikmo was very susceptible to the disease. Typical blight was produced after a few days on both the injured and uninjured leaves (fig. 5). Infection was obtained on the avocado when the uninjured leaves were inoculated on the lower surface. No infection was obtained, however, when the fungus was applied on the upper uninjured surface of the leaves.

Taxonomy

According to the results of the writers' morphological studies, the conidiophores of the imperfect stage of the *Glomerella* which causes anthracnose of black pepper in the Philippines are 21.0-175.0

x 3.5-5.2 μ and the conidia 12.2-19.2 x 3.5-7.0 μ. In Shear and Wood's (1913) paper, the conidia of the mango (*Mangifera indica* Linn.) strain of *Glomerella cingulata* (Stonem.). S. and v. S. are 12.0-25.0 x 3.5-6.0 μ and those of the avocado (*Persea americana* Mill.) strain are 12.0-18.0 x 4.5-6.0 μ. These authors further report that the conidia of the avocado strain from field materials are 11.0-19.5 x 4.5-5.5 μ. The conidia produced in culture by the apple strain of *Glomerella cingulata* are 10.0-28.0 x 3.5-7.0 μ; the average is 19.0 x 5.25 μ. On privet (*Ligustrum vulgare* Linn.) the conidia of *G. cingulata* are 12.0-33.0 x 4.5-7.0 μ in culture and 12.0-21.0 x 4.5-6.0 μ on the host. On grape, the conidia of *G. cingulata* are 12.0-15.0 x 4.0-5.0 μ and on the black raspberry, 10.5-18.0 x 5.0-6.5 μ. Shear and Wood (1913) consider these different strains of *Gloeosporium* as imperfect stages of *Glomerella cingulata* (Stonem.) S. and v. S.

Because of the closeness in size of the conidia of the *Gloeosporium* on black pepper to those of Shear and Wood's (1913) strains on avocado and mango *Gloeosporium*, the black pepper fungus in the Philippines is provisionally referred to the species *Glomerella cingulata* (Stonem.) S. and v. S.

How the fungus lives between seasons

In the Philippines, species of *Glomerella* are weakly parasitic in their imperfect stages. They are cosmopolitan organisms and may be found on weakened or dead plants. The perfect stage is a saprophyte, and the fruit bodies of this stage may be found on dead or rotting host plants on the ground. Under conditions in the Philippines, the fungus can remain in the inactive stage on the host tissues during adverse weather.

Dissemination of the fungus

Agati (1921) showed that the conidia of *Gloeosporium musarum* Cke. and Massee on banana are disseminated by wind and by insects. Higgins (1913) reported that wind helps in the dissemination of the spores of *Gloeosporium* in the field. According to Edgerton (1908), conidia of *Gloeosporium nervisequum* can not be blown away by the wind because they are held firmly by a mucilaginous substance. He believes that spore dissemination is effected by rain. Clinton (1902) states that the conidia of *Gloeosporium fructigenum* are disseminated by small pomaceous flies of the genus *Drosophila*.

The writers studied the dissemination of the spores both in the experimental plot and in the laboratory. Sterilized Petri dishes containing sterile potato-dextrose agar were exposed for five minutes at different distances from the diseased plants in the experimental plot. The Petri dishes were opened and faced the wind which blew through the infected plants. They were placed at a distance of one half meter, one meter, and three meters, respectively, from the infected plants.

The Petri dishes were then kept in the laboratory and observed for the germination of the spores which had been caught. After about forty-eight hours, the plates were examined under the low power of the microscope. Some spores of the black pepper *Gloeosporium* had already germinated. More were seen in the plates near the diseased plants than in those farther away.

In determining the dissemination of spores by rain and water as splashes, sterile water was sprayed on the diseased leaves, and the droplets of water passing over infected areas were caught with test tubes containing dissolved sterile potato-dextrose agar. The droplets were mixed thoroughly with the agar, and the mixture was poured into sterile Petri dishes. After the dishes had been kept in the laboratory for forty-eight hours, some germinating conidia of the black pepper *Gloeosporium* could be readily detected under the microscope. The conidia looked very much like those of the *Gloeosporium* stage of *Glomerella cingulata*. For short distances, it seems that the spores can be readily disseminated by wind, rain, or water passing over the lesions.

SEASONAL OCCURRENCE OF THE DISEASE

The writers observed that the first occurrence of the disease in the field during the year was at the beginning of the rainy season, especially during the months of June and July. The disease seemed to start on leaves that were partly burned at the tip or on those that had been greatly weakened by exposure to sunlight in the preceding months. The conditions that favor disease production are rainy days when the temperature is low and the presence of burned or scalded areas on the leaves.

The disease was prevalent only on weakened plants. The heat of the sun affected the growth in size of the infected areas on these plants. Infection of the pepper was severe on those plants of which the leaves had been either burned or scalded by direct sunlight.

CONTROL MEASURES

Because of the absence of large fields of black pepper in the locality, methods for the control of the disease could not be studied. In the inoculation experiments, the fungus was only weakly parasitic on black pepper. The disease developed slowly and infected leaves that had been burned or scalded by the sun during the preceding dry season. Infection took place on these dying parts of the leaves and on young leaves under moist conditions. On account of the slow development, the writers were able to keep their plantings free from the disease by removing the infected leaves occasionally and burning them. When placed under partial shade and supplied with a little ammonium sulphate or decayed organic matter, slow growing plants that had infected leaves from time to time improved in growth and produced leaves which were free from anthracnose.

Black pepper plantings that had been kept in the open during the summer months of 1930 became infected with the disease during the rainy season because the preceding summer had scorched some of the leaves. The fungus started its growth from the sun-scorched leaves. These plants recovered from the disease, however, after the infected leaves had been removed and the plants given good care.

The experiments further show that black pepper was resistant, and that the cultivated *Piper betle* was susceptible to the disease.

SUMMARY

1. Anthracnose is a minor disease of black pepper (*Piper nigrum* Linn.). It attacks the foliage and produces dead areas which interfere with the function of the leaves.

2. In the early stage of the disease, the lesions are small and dark gray, irregular in size and shape, and have a distinct border. In the advanced stage, the lesions enlarge and merge together forming large, dead areas.

3. The mycelium of the fungus is septate, coarse, hyaline, and granular in contents, either simple or branched, and $15.7 \times 6.1\ \mu$.

4. The conidiophores are simple, hyaline, granular, non-septate, and $98.0 \times 4.3\ \mu$. Each conidiophore produces two to six or more conidia at the tip.

5. The conidia are thin-walled, rounded at the ends, oblong-elliptical, hyaline, with granular contents, easily detached from the conidiophores, and $15.7 \times 5.2\ \mu$. In masses the spores are pinkish but become dark or almost black with age. At germination the conidia may produce either one or two germ tubes. On contact with hard surfaces, the germ tubes produce appressorium-like dark bodies.

6. The fungus is referred to the species *Glomerella cingulata* (Stonem.) S. and v. S., but it produces only the imperfect stage.

7. The spores of the fungus are disseminated perhaps by wind, rain, or water passing over the infected areas of the leaves.

8. Under climatic conditions in the Philippines, the fungus can remain in the form of dormant mycelium in the infected host tissues during dry weather.

9. Rainy days favor spore-germination and penetration of the host. Young and tender leaves and sun-scalded and sun-burned areas are readily infected by the causal fungus.

10. The disease may be controlled by collecting and burning the infected leaves.

11. As the disease attacks only slow growing and weakened plants and does not infect actively growing black pepper, plantings should be given good care in order to stimulate vigorous growth and enhance resistance to the disease.

12. As sun-burned and sun-scalded leaves are readily infected by the fungus, a partial shade of the vines during the hottest part of the year should be a good precaution against heavy infection during the following rainy season.

LITERATURE CITED

AGATI, J. A. 1921. Banana stem and fruit rot. The Philippine Agriculturist 10: 411–421.

CLINTON, G. P. 1902. Apple rots in Illinois. Illinois Agric. Exper. Sta. Bull. 69: 189–244. *Pl. A-J.*

EDGERTON, C. W. 1908. The physiology and development of some anthracnose. Bot. Gaz. 45: 367–408. *Pl. 11, fig. 1–17.*

HIGGINS, J. E. 1913. Report of the Horticulturist. Ann. Rept. Hawaii Agric. Exper. Sta. 1912: 35–44. *Pl. 2–5.*

OCFEMIA, G. O. 1925. The Phytophthora disease of eggplant in the Philippine Islands. The Philippine Agriculturist 14: 317–328. *Fig. 3.*

OCFEMIA, G. O., AND EMILIANO F. ROLDAN. 1927. Phytophthora blight of citrus. Amer. Jour. Bot. 14: 1–15. *Pl. 1–2.*

REINKING, OTTO A. 1923. Comparative study of *Phytophthora faberi* on coconut and cacao in the Philippine Islands. Jour. Agric. Res. 25: 267–284. *Pl. 1–12, fig. 1–5.*

ROSENBAUM, J. 1917. Studies of the genus Phytophthora. Jour. Agric. Res. 8: 233–276. *Pl. 71–77, fig. 1–13.*

SHEAR, C. L., AND ANNA K. WOOD. 1913. Studies of fungous parasites belonging to the genus *Glomerella*. U. S. Bur. Plant Indus. Bull. 252: 1–110. *Pl. 1–18, fig. 1–4.*

WESTON, WILLIAM H., Jr. 1920. Philippine downy mildew of maize. Jour. Agric. Res. 19: 97–122. *Pl. 16–25.* (*A* and *B col.*).

WESTON, WILLIAM H., Jr. 1921. Another conidial Sclerospora of Philippine maize. Jour. Agric. Res. 20: 669–684. *Pl. 76–79.*

TABLE 1

The ratios of lengths to widths of 100 conidia of the blight of black pepper (Piper nigrum Linn.) Gloeosporium distributed in classes made by a difference of 0.25 micron

RATIO CLASSES IN MICRONS	NUMBER OF CONIDIA IN 100
1.94 – 2.18	14
2.19 – 2.43	48
2.44 – 2.68	20
2.69 – 2.93	1
2.94 – 3.18	3
3.19 – 3.43	1
3.44 – 3.68	8
3.69 – 3.93	2
3.94 – 4.18	3

A COMPARATIVE STUDY OF THE EFFECTS ON YIELD OF CORN OF SOME LEGUMINOUS CROPS USED AS GREEN MANURE [1]

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Of the Department of Agricultural Education

Green manuring is one of the practices used to increase crop yields. Although it is considered good, its importance is not fully known to the average Filipino farmer. Those who plant legumes do so not for the green manure but for the production of seed, young pods, flowers, and other parts which may be used as food. When so planted, the legumes if annuals, add very little fertility to the soil.

Hutcheson and Wolfe (1924) said that although a green manure crop has been shown to have a marked residual value, the exact worth of this has not been worked out. A study of the residual value of various green manure crops to the succeeding crops should be a promising field for further investigation; hence the experiment reported in this paper was undertaken.

Pieters (1927) concluded that the greatest response to green manures had been observed with crops like corn, and for such crops green manures are to be recommended. At the Arkansas Agricultural Experiment Station corn grown after cotton produced 25.6 bushels per acre (19.68 cavans per hectare); after cowpea stubble, 33.6 bushels per acre (38.96 cavans per hectare); and after cowpea crop plowed under, 39.7 bushels per acre (46.04 cavans per hectare). A higher yield of wheat was obtained when soybean was plowed under than when it was cut for hay or not used at all.

Mr. Clemente E. Yango of the Department of Agronomy studied the comparative effect of Hoz fertilizer and Crotalaria upon the yield of corn. He found that either gave a higher yield than the control, but Hoz fertilizer gave the highest.

Löhnis (1926) found that young green manures in small amounts generally gave higher immediate returns than larger amounts of old materials. He noted, however, that cowpea is an exception because the available nitrogen increases as the plant becomes older.

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[1] Experiment Station contribution No. 1364. The criticisms and suggestions received from Professors N. B. Mendiola and V. B. Aragon of the Department of Agronomy, College of Agriculture are acknowledged.
Read before the Los Baños Biological Club, February 29, 1940.

Alonso (1932) found that the percentage of nitrogen decreased in leguminous plants towards maturity. The quantity per square meter, however, increased as the plants grew older. He also found that mungo and cowpea are among the best crops if the time for green manuring is only four to seven months.

Calma (1938) observed that mungo, soybean, and cowpea germinated in two to three days. It took forty-four days for mungo to reach the flowering stage, forty-eight days for soybean, and fifty-eight days for cowpea. The legumes were ready to be turned under forty-five to sixty days, and the different green manures took about twenty days to decay completely. He noted that mungo had the best stand and growth and proved to be the best of the three green manure crops tried.

Aquino and Madamba (1939) noted that the more root nodules formed, the higher the gain in nitrogen. They believe that the increase in nitrogen fixation might probably continue until the plants begin to produce flowers or blossoms, provided all factors are favorable.

Barros [2] and Duarte,[3] working separately on the effects upon the yield of corn of *Calopogonium muconoides* Desv. as a green manure, found that planting the legume at different periods of corn growth had different effects upon the yield. They noted that when Calopogonium was planted at the same time as the corn seeds, the corn increased in yield, but when planted during the flowering and milk stages, it did not. They observed in both experiments that the growth of weeds was to a certain extent checked by the *Calopogonium.*

Object of the present work

The object of the present work was to determine the effects on the yield of corn of some leguminous crops used as green manure.

Time and place of the work

The experiment was conducted on the farm of the University Rural High School, College of Agriculture, Los Baños, Laguna, from August 2, 1938 to March 15, 1939.

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[2] BARROS, FRANCISCO. When to plant *Calopogonium muconoides* Desv. as green manure to corn. (Special problem in Agronomy. 1932. Unpublished.)

[3] DUARTE, VENANCIO C. The effect upon the yield of corn of planting *Calopogonium muconoides* Desv. as green manure: The *Calopogonium* planted with the seeds of corn, at flowering stage and milk stage. (Thesis presented for graduation from the College of Agriculture. 1934. Unpublished.)

MATERIALS AND METHODS

Corn and legumes used

The corn used in the study was the Native Yellow Flint variety, and the legumes were peanut, cowpea, mungo, and soybean.

Planting the legumes

The land was plowed twice and harrowed once after each plowing. It was divided into thirty small plots, five by ten meters each. Six were used for each of the green manures and six for control. They were arranged in the checker board way.

The seeds of mungo (*Phaseolus aureus* Roxb.), cowpea, and soybean were broadcast as uniformly as possible in the different plots on August 19, 1938. The plots were harrowed several times until the seeds were covered with soil. In planting peanut, holes about 15 centimeters apart each way were made with a dibber and one seed of peanut was dropped into each. About 0.3 liter of seed of each of the legumes was used per plot or 60 liters per hectare.

On October 11, 1938, during the blooming period, the green manure plants were chopped into small pieces with a bolo and spread as uniformly as possible on each plot. Then they were plowed under and allowed to decay.

Planting the corn crop

For corn the land was prepared in the usual manner. It was plowed and harrowed once after plowing under the green manure. The corn seeds were planted by hand on November 19, 1938 in furrows one meter apart and in hills 80 centimeters apart in the row. Four or five seeds were dropped on each hill and covered with soil by the feet.

Cultivating and thinning. The plants were cultivated twice with a plow; first when they were about three weeks old, and next, about one week after. They were thinned to three per hill soon after the second cultivation.

Harvesting, classifying, and shelling. The ears were harvested on March 1, 1939 by husking them from the standing stalks. The harvest from each plot was classified and dried separately. The ears were classified as follows: first class, 21.2 centimeters or more in length; second class, 18.1 to 21.1 centimeters; third class, 14.4 to 18.0 centimeters; fourth class, 10.6 to 14.3 centimeters; and fifth class, 10.5 centimeters or below.

The ears were divided in two groups, marketable and non-marketable. The marketable group included all the first, second, third, fourth, and fifth classes; and the non-marketable, the nubbins and the damaged ones. When 50 per cent of an ear in any of the classes was destroyed, it was considered damaged. The ears were shelled with a corn sheller, and the grains were weighed.

RESULTS AND DISCUSSION

Field observations

Observations on green manure culture. The four legumes germinated in two to six days. The average number of days from sowing to blooming of the different legumes was as follows: peanut, thirty days; mungo, forty-five days; cowpea, fifty days; and soybean, fifty-three days. Mungo had the best stand of plants followed by cowpea, soybean, and peanut. Except in peanut, the weeds were largely kept down by the luxuriant vegetative growth of the green manure crops. The green manures decomposed in about four weeks. White ants fed on the woody portions of the stems of the green manures soon after they were turned under.

Observations on corn culture. In general the corn plants in the green-manured plots were more vigorous than those in the control. No marked difference occurred in the stand of the plants in the different green-manured plots. The corn seeds germinated in three to four days, and the corn plants flowered in five to six weeks and matured about one-hundred days after they had been planted.

Yield

Table 1 shows the actual yields in ears of corn of the different plots. Under marketable ears, mungo produced the most first class (5 ears), and the control, the least (1 ear); cowpea, the most second class (83 ears) with mungo (79 ears) a close second, and soybean, the least (53 ears); mungo, the most third class (412 ears), and the control, the least (275 ears); the control, the most fourth class (405 ears), and mungo and cowpea, the least (335 ears each); and the control, the most fifth class (173 ears) with cowpea (170 ears) a close second, and mungo, the least (131 ears). Under non-marketable ears the greatest damage (41 ears) was in soybean, and the least (28 ears) in mungo. The greatest number of nubbins was obtained from cowpea (143 ears), and the least from the control (75 ears). The yield of shelled corn from the different plots is shown in table 1. The

highest yield, 15.38 kilograms, was obtained from plot 16, green-manured with peanut. Plot 3, green-manured with cowpea, gave the lowest yield, 7.94 kilograms.

Table 2 shows the computed average number of ears per hectare of the control and the green-manured plots. Mungo gave the highest average yield (36,263 ears) per hectare, followed by cowpea (36,100 ears), soybean (35,033 ears), and peanut (34,233 ears). The control gave the lowest average yield, 33,966 ears. The computed average yield of shelled corn is also shown in table 2.

Table 2 also shows the computed average yield in cavans per hectare of the control and the green-manured plots. As the basis of computation, the weight of one cavan of shelled corn was placed at 58.5 kilograms. The average yield of the control was 40.80 ± 1.58 cavans; cowpea, 41.49 ± 2.35; peanut, 43.17 ± 1.77; soybean, 43.55 ± 1.33; and mungo, 46.50 ± 0.97. The mungo gave the highest yield; the control, the lowest. The plots green-manured with mungo gave the highest percentage of increase in yield, 13.97 per cent, whereas those green-manured with cowpea, the lowest, only 1.69 per cent.

A comparison of the difference in yields of the control and the green-manured plots is shown in table 3. The greatest increase, which is statistically significant, was obtained from plots green-manured with mungo.

SUMMARY

1. The comparative efficiency of peanut, cowpea, mungo, and soybean as green manure for corn was studied.

2. The average yield per hectare in cavans of shelled corn obtained from the control and the green-manured plots was as follows: control, 40.80 ± 1.58; cowpea, 41.49 ± 2.35; peanut, 43.17 ± 1.77; soybean, 43.55 ± 1.33; and mungo, 46.50 ± 0.97.

3. The average yield of each of the green-manured plots was higher than that of the control. The greatest increase, 5.70 cavans, was obtained from the plots green-manured with mungo. The value of the difference is statistically significant.

LITERATURE CITED

ALONSO, CELESTINO S. 1932. A test of some green manure crops. The Philippine Agriculturist 23: 543–558.

AQUINO, D. I. AND A. L. MADAMBA. 1939. A study of root nodule of certain leguminous plants. The Philippine Agriculturist 28: 121–132.

CALMA, V. C. 1938. Comparative effects of ammonium sulfate and legumes on the yield of sugar cane. Philippine Agriculturist **27**: 31–42.

HUTCHESON, T. B., AND T. K. WOLFE. 1924. The production of field crops. xv + 499p. New York: McGraw-Hill Book Co., Inc.

LÖHNIS, F. 1926. Nitrogen availability of green manures. Soil Science **22**: 253–290.

PIETERS, A. J. 1927. Green manuring. xiv + 356 p. New York: John Wiley and Sons.

TABLE 1

Yields from the different plots

PLOT NO.	GREEN MANURE	CLASS OF MARKETABLE EARS					NON-MARKETABLE EARS		YIELD OF EACH PLOT (SHELLED CORN)
		First	Second	Third	Fourth	Fifth	Damaged	Nubbins	
									kilograms
2	Control	0	12	46	57	22	0	13	11.40
6	"	0	10	41	86	16	9	13	12.58
13	"	0	3	37	86	38	7	5	10.20
17	"	0	14	57	75	36	8	18	14.82
21	"	1	10	41	61	37	7	9	11.64
28	"	0	7	53	60	24	3	17	11.00
		1	56	275	405	173	34	75	71.64
1	Peanut	1	10	42	58	20	0	15	10.35
5	"	1	18	43	59	22	8	16	12.39
9	"	0	10	67	69	18	5	4	13.70
16	"	0	12	68	70	40	7	17	15.38
20	"	0	5	48	77	36	6	11	13.14
24	"	0	6	44	60	18	2	14	10.86
		2	61	312	393	154	28	77	75.82
3	Cowpea	0	16	47	50	22	0	14	7.94
10	"	0	8	68	56	41	4	37	13.99
14	"	1	9	51	57	29	9	19	11.88
18	"	1	15	55	59	37	7	18	11.91
25	"	2	25	52	60	15	1	31	15.28
29	"	0	10	46	53	26	7	24	11.82
		4	83	320	335	170	28	143	72.82
4	Mungo	2	16	49	64	6	4	34	13.30
8	"	0	7	69	58	32	8	4	13.80
12	"	1	14	73	54	46	2	29	14.24
19	"	1	11	64	55	21	3	7	12.35
23	"	1	16	80	47	11	3	14	15.07
27	"	0	15	77	57	15	6	12	12.86
		5	79	412	335	131	26	100	81.62
7	Soybean	0	3	57	66	18	5	17	11.60
11	"	0	14	78	52	43	4	19	13.11
15	"	0	14	68	61	14	20	6	13.28
22	"	2	6	62	70	24	3	18	14.61
26	"	1	9	49	72	31	6	4	13.23
30	"	0	7	50	43	14	3	18	10.60
		3	53	364	364	144	41	82	76.43

TABLE 2

The computed average yield per hectare of the control and the green-manured plots

GREEN MANURE	REPLICATION	AVERAGE YIELD PER HECTARE			INCREASE IN YIELD	
		Ears	Shelled corn			
	number	*number*	*kilograms*	*cavans*	*cavans*	*per cent*
Control ...	6	33,966	2,386.80	40.80 ± 1.58	—	—
Cowpea ...	6	36,100	2,427.17	41.49 ± 2.35	0.69	1.69
Peanut ...	6	34,233	2,525.45	43.17 ± 1.77	2.37	5.80
Soybean ..	6	35,033	2,547.68	43.55 ± 1.33	2.75	6.74
Mungo ...	6	36,266	2,720.25	46.50 ± 0.97	5.70	13.97

TABLE 3

The difference in yield per hectare over the control

	DIFFERENCE IN YIELD PER HECTARE	VALUE OF DIFFERENCE
	cavans	
Cowpea vs. control	0.69 ± 2.83	Insignificant
Peanut vs. control	2.37 ± 2.37	Insignificant
Soybean vs. control	2.75 ± 3.17	Insignificant
Mungo vs. control	5.70 ± 1.85	Significant

A STUDY OF SOME OF THE IMPORTANT CHARACTERS OF COTTON VARIETIES GROWN FROM SELFED AND UNSELFED SEEDS [1]

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WITH SEVEN TEXT FIGURES

When two or more cotton varieties are grown in close proximity, a certain degree of vicinism is likely to occur as a result of cross pollination brought about by pollinating agents, mainly insects. The seeds obtained from each of the varieties will likely include a certain percentage of hybrids which will produce individual plants with characters that are probably different from those of the original parent varieties. The degree of vicinism is not known in some cotton varieties, and it differs under different conditions.

Kearney (1923) says that from the point of view of maintaining varietal purity, a very small proportion of vicinism must be regarded as a menace, and a few accidental hybrids, unless they are promptly eliminated, will eventually contaminate the stock.

No work has been done on the degree of cross pollination among cotton varieties in the Philippines. There are a number of cotton varieties, such as the Pima Egyptian and the Gizas, which have been introduced recently into the College of Agriculture. Should these introduced varieties grow profitably in the Philippines, the maintenance of the purity of seeds would be an important matter for consideration. A study is therefore made of some of the characters of cotton varieties grown from selfed and unselfed seeds to determine the degree to which each variety is subject to natural cross fertilization under Los Baños conditions.

Review of literature

Vicinism. Since this work deals with Egyptian varieties of cotton which have been introduced recently into the College of Agriculture, it is necessary to review the past work both for the effect of

[1] Experiment Station contribution No. 1365. The writers are indebted to Professor N. B. Mendiola, Head of the Department of Agronomy, and to Assistant Professor J. M. Capinpin, of the same Department, for their suggestions and help in the preparation and revision of this paper.

an introduction of new varieties of cotton and for that of natural crossing on the varietal characteristics.

Cook (1909) in the United States, concluded that when new varieties of cotton are grown in a locality, two kinds of changes are found to follow transfer to a new place; first, the change of accommodation to a different condition, and second, the diversification or loss of uniformity. Recurrence of these changes may be quite independent of the ultimate effect of hybridization, natural or artificial. The new condition may induce diversity in an indirect manner by disturbing the processes of heredity and thus allowing ancestral characters that have been transmitted in latent form to return to expression, or characters previously expressed to become latent.

Balls (1912), in Egypt, found the average percentage of natural crossing to be 13.3.

Kearney (1913), stated that even when cotton is grown from carefully selected seed and planted where crossing with other varieties is impossible, all varieties of cotton produce a certain percentage of off-type and inferior plants. He further concluded that diversity may be controlled by avoiding extremely light and extremely heavy soil and by proper irrigation to prevent severe drought and excessive moisture.

Kearney (1914), grouped the grounds for mutation origin into two, namely, (1) supposed hybrid origin and (2) later crossing with other types. In 1921, working on hereditable variation in Egyptian cotton, he found that Pima was probably the most uniform variety of cotton then grown on an extensive scale in the United States. Records of breeding work with Pima cotton by Kearney in 1921 supply additional evidence of the occurrence of a number of slight heritable variations, none of which could be considered as outside normal range of variation of this variety. According to Kearney (1921), the complete or nearly complete absence of a dark red spot on the claw or at the base of the petal of the flowers of Egyptian varieties and the increased percentage of 4-lock bolls are considered striking variations and found to be heritable in a high degree.

Kearney (1923) stated that when any two varieties are grown in close proximity in a place where pollinating insects are abundant, the number of vicinists in populations grown from the resulting seed seldom exceeded 20 per cent and was often much lower. In the same year, he found that the average percentage of the cross-fertilized ovules under this condition was 12 in Pima Egyptian cotton and 28 in Acala.

b. Agronomic and morphological characters of flower and boll. Not much work has been done on comparison of the agronomic merits and morphological characteristics of the varieties used in this study, the Pima and the Giza. More work has been done with the Pima Egyptian than with the Giza varieties.

Kearney (1923) described the Pima Egyptian cotton grown in Arizona as follows:

Flowers, yellow, with dark red or purple claw at the base of the petal; boll, rather rough surfaced, long, and tapering; length of fiber about 3-4 cm.; and seeds not united, and not fuzzy.

Bailey and Trought (1926) gave the following results: (1) Normal period of flower development not less than 42 days. (2) Normal period of complete boll development about 52 days; the diseased ones open earlier. (3) Plants under drought conditions show a somewhat shortened boll-maturation period.

King (1922) found that on the average, 3000 bolls on Pima Egyptian cotton mature in 68 days and that early bolls mature within a much shorter period than later bolls. He found further that the mean interval between the opening of the flower and the completion of the shedding process is 10 days, and that the period tends to increase as the season advances.

Objects of the work

The objects of the present work were: (*a*) to compare cotton plants raised from selfed seeds with those grown from unselfed seeds within each variety and (*b*) to study the important agronomic and gross morphological characters of each of the varieties under investigation.

Time and place of the work

The cultural operations of this study were performed in the Experiment Station grounds and the laboratory part was done in the laboratory of the Tobacco and Cotton Division, Department of Agronomy, College of Agriculture, Los Baños, Laguna, from May, 1936, to May, 1937.

MATERIALS AND METHODS

Varieties of cotton used

Five varieties of imported cotton were used, namely, Pima Egyptian Lot I, Pima Egyptian Lot II, Giza 7, Giza 12, and Giza 19 (fig. 1-4).

The seeds of Pima Egyptian Lot I were obtained by Dr. Bienvenido M. Gonzalez, former Dean of the College of Agriculture, from the United States Department of Agriculture in 1931; those of Pima Egyptian Lot II by the senior author from the Cotton and Plant Pests Division of the United States Department of Agriculture in 1935; and those of Giza 7, Giza 12, and Giza 19, in the same year, from the Ministry of Agriculture, Cairo, Egypt.

Fig. 1.—A typical flower of the Pima Egyptian variety of cotton showing a distinct and dark purple spot on the claw of each petal. The color of the corolla is light greenish yellow. Photograph by Star Studio, Los Baños, Laguna.

Selfed and unselfed seeds

Selfed and unselfed seeds of each of the above mentioned varieties were used in this study. The selfed seeds were obtained by the senior writer from bolls raised from bagged flowers and from the individual plants produced from isolated cotton grown in petroleum cans. These plants were cultured where there was no other variety of cotton grown in the vicinity. The unselfed seeds of each variety were obtained by the junior author in fields where other varieties were also grown. In this experiment, unselfed seeds were obtained from the following two fields: Field 1, 50 × 50 meters, which was

planted to Giza 7, Giza 12, Giza 19, Pima Egyptian Lot I, Pima Egyptian Lot II, Meade A-71, and Seagypt in the order given above. Field 2, 125 × 90 meters, which was planted to Giza 7, Giza 12, Giza 19, Black Bagley, Family A, Harper Family U. I. A. Brazilian 7111-045, I. A. Brazilian 7470, Sea Island, Acala, Cleveland Big Boll, Seagypt, Meade A-71, Moco-Grupo A, Moco 0.0, Moco-Grupo B, Variety 624, Seregy, and Texas in the order given. Fields 1 and 2 were separated by the main road of the Experiment Station grounds.

Fig. 2.—An off-type flower of the Pima Egyptian variety of cotton showing a very small and faded spot on the claw of the petal. The color of the corolla is pale cendre green. Photograph by Star Studio, Los Baños, Laguna.

Land

The soil in the field used in this study was medium clay loam. A one hectare field, after being plowed and harrowed three times, was divided into ten parts, each of which measured 10 × 100 meters. Each division had a total area of 1,000 square meters, which was further divided into five smaller plots. Each variety was planted in five plots arranged in a checker-board fashion; hence it was replicated five times.

Treatment of seeds

Since seeds of different varieties of cotton used in this experiment had a low viability and the amount was limited, selection was made for healthy and plump seeds. Immediately before planting, the seeds were soaked in hot water having a temperature of about 70°C. for approximately ten minutes to hasten germination. Seeds thus treated were all planted in the same way and on the same day.

Fig. 3.—An off-type flower of the Pima Egyptian variety of cotton showing total absence of the dark purple spot on the claw of the petal. The color of the corolla is pale cendre green. Photograph by Star Studio, Los Baños, Laguna.

Sowing of seeds

Five seeds were dropped into each hole in furrows one meter apart. The holes in the furrows were also one meter apart. When the seedlings were two weeks old and about ten centimeters above the ground, they were thinned to one vigorous plant to a hill.

Weeding

A light garden hoe was used in weeding, which was started just after the seedlings had been thinned to one plant to a hill. This operation was continued up to April 30, 1937.

Cultivation

Cultivation was done at the same time as weeding. The first cultivation was shallow to avoid injury of the roots of the young plants. The plots were cultivated as often as necessary.

Determination of comparative agronomic merits

The determination of the comparative agronomic merits of the different varieties studied was recorded under the following headings: (1) age at which a given variety began to square, flower, and boll; (2) age at which a given variety began to mature its boll (length of maturity of boll from date of planting): (3) rate of shedding of boll; (4) percentage of fiber; (5) percentage of seed; (6) percentage of bract and capsule; (7) yield of seed cotton and lint of each variety; and (8) persistence of locks in capsule.

Formation of square, flower, and boll. In order that the exact date when each variety began to square, flower, and boll might be known the field in which the different varieties were planted was visited daily, beginning on December 11, 1936, and ending on February 2, 1937. Records of formation of square, flower, and boll of each variety studied were made on 100 plants taken at random.

Maturity of boll. As the field was visited daily, the dates of boll maturity of the different varieties of cotton under investigation were recorded.

Shedding of boll. From January 10, 1937, to March 2, 1937, the number of bolls shed from 100 plants of each variety under study was recorded every other day in order to determine the rate of shedding of bolls of each variety studied.

Percentage of fiber, seed, bract, and capsule. One hundred mature open bolls of each variety studied were harvested at random from the field. The bract, capsule, lint, and seed were separated by hand and weighed.

Yield. All mature open bolls of each variety from the entire field were picked, and the amount of harvest was determined accord-

ingly. The yield of seed, cotton, and lint of each variety studied was determined actually, and then computed on a hectare basis.

Persistence of locks in capsule. Persistence of locks in capsule was determined by noting the resistance they offered when they were pulled by hand from the lobes of the capsule of the cotton boll.

Gross morphological characteristics

Certain morphological characters of each of the varieties from selfed and unselfed seeds were studied and recorded under the following headings: (1) size and shape of bolls; (2) quality of staple according to uniformity of length, silkiness, color, and texture; (3) color of petals before and after opening of corolla; and (4) number of locks of bolls.

Size and shape of bolls. One hundred bolls taken at random from plants of each variety studied were measured to find the length and diameter. They were classified into groups of different distinct shapes, as conical, ovate-acuminate, orbicular-cuspidate, and orbicular-mucronate figure 4.[2] The percentages of bolls of each variety under investigation were determined according to shape.

Quality of staple. Of each variety, one hundred bolls were taken at random, and the seeds together with the lint separated by hand. The seeds with lint still on were mixed, and from the mixture one hundred seeds bearing lint were taken at random for measuring the length of the staple. After the measurement on length of the fiber was done, the lint was further separated from the seeds by hand and prepared for a study of its silkiness, color, and texture by fluffing the fiber (table 4).

Color and shape of corolla. The flowers of 100 plants of each variety studied were set aside for color and shape study. For color determination, Ridgway's (1912) *Color Standards and Color Nomenclature* was consulted (fig. 1, 2, and 3).

Number of locks of boll. The average number of locks per boll of each variety was determined by counting the number of locks in 100 bolls harvested from the field and dividing the total number of locks by the total number of bolls used in this particular part of the work (fig. 5).

Percentage of vicinists. Some of the characters used for detecting vicinism are deviations from the typical color of the petal of

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[2] The terms "ovate" and "orbicular" refer to shapes of bolls, while "acuminate", "cuspidate", and "mucronate," to apices of the bolls.

the corolla of a given variety, absence or modification of the purple spots on the claws of the petals, anther color, fuzziness, and non-fuzziness of the seeds, and character of the midlock furrows of the boll. The percentage of vicinists in a given variety was determined by dividing the number of "off-types" by the total number of plants studied and multiplying the quotient by 100.

EXPERIMENT AND RESULTS

Table 1 presents the data on the period of maturity of reproductive organs and rate of shedding of bolls of different varieties of cotton studied; table 2, the data on the morphological and the agro-

Fig. 4.—Mature bolls of the Pima Egyptian and the Giza varieties of cotton. *a*, *b*, and *c* are bolls of the Pima Egyptian of both lots, with definite shapes: *a*, conical; *b*, ovate-accuminate; and *c*, orbicular-cuspidate; *d*, *e*, *f*, and *g* are bolls of the Giza varieties, with definite shapes; *d*, conical; *e*, ovate-acuminate; *f*, orbicular-cuspidate; and *g*, orbicular-mucronate. Photograph by Star Studio, Los Baños, Laguna.

nomic characteristics of bolls; table 3, the relative percentage of the different parts of the bolls; table 4, the distinct characteristics of the fiber of the different varieties; table 5, the data on the actual and computed yield of seed cotton and lint of the different varieties; and table 6, the relative percentage of vicinists observed in the different varieties.

DISCUSSION OF RESULTS

According to the data presented in table 1, the bolls of Pima Egyptian Lot I grown from selfed and unselfed seeds matured in 152.8 and 146.9 days, respectively; Pima Egyptian Lot II, 145.6 and

149.9 days; Giza 7, 152.4 and 155.1 days; Giza 12, 147.0 and 152.2 days; and Giza 19, 150.0 and 155.2 days. As shown by the above figures, no relation exists between the period of maturity of bolls grown from selfed and unselfed seeds.

The rate of shedding of immature bolls, as shown by the figures presented in table 1, seems to be very variable in all the varieties studied. It was observed that those bolls which were borne on the terminal branches, both vertically and laterally, had a greater rate of shedding than those bolls which were produced within the interior

Fig. 5.—Mature bolls of Pima Egyptian and of Giza varieties of cotton with different numbers of locks. *a*, a Pima Egyptian cotton boll with four locks; *b*, a Pima Egyptian cotton boll with three locks; *c*, a Giza cotton boll with four locks; *d*, a Giza cotton boll with three locks; and *e*, a boll of Giza 7 variety with two locks. Photograph by Star Studio, Los Baños, Laguna.

parts of the cotton plants. The average age of immature bolls grown from selfed seeds when they were shed from the reproductive branches ranged from 3 days in Pima Egyptian Lot I to 12 days in Giza 12, those from unselfed seeds, from 8 days in Giza 7 and Giza 19 to 14 days in Giza 12.

In all varieties studied, the unopened flowers, whether grown from selfed or unselfed seeds had a darker yellow color than the opened flowers. It was generally observed in the field that the flowers of the Pima Egyptian plants of both lots exhibited a darker yellow

color than those of the Gizas, whether grown from selfed or unselfed seeds. The opened flowers of the Pima Egyptian Lot I and Pima Egyptian Lot II grown from unselfed seeds had a wider range of color. On the other hand, the opened and unopened flowers of the Gizas grown from selfed and unselfed seeds had the same range of color, respectively. The dominant color of the unopened flowers of the Pima Egyptian plants of both lots and the Gizas whether grown from selfed or unselfed seeds was from pinard yellow to picric yellow, while that of the opened flowers was from pale green yellow to light green yellow.

As shown in table 2, the bolls of the selfed Pima Egyptian of both lots were longer and wider than those of the selfed Gizas. For the unselfed varieties, Pima Egyptian Lot I also produced longer and wider bolls than the Gizas, while Pima Egyptian Lot II, although its bolls were wider than any of the Gizas and longer than those of Giza 12 and Giza 19, produced shorter bolls than Giza 7. The selfed Pima Egyptian Lot I bolls measured 4.51 $\pm$ 0.038 centimeters long and 2.34 $\pm$ 0.020 centimeters wide; unselfed, 4.36 $\pm$ 0.036 centimeters long and 2.37 $\pm$ 0.021 centimeters wide. For selfed Pima Egyptian Lot II, the bolls measured 4.10 $\pm$ 0.037 centimeters long and 2.28 $\pm$ 0.021 centimeters wide; the unselfed, 4.02 $\pm$ 0.040 centimeters long and 2.30 $\pm$ 0.028 centimeters wide. In the case of Giza 7, the selfed bolls measured 4.06 $\pm$ 0.030 centimeters long and 2.18 $\pm$ 0.014 centimeters wide; the unselfed, 4.26 $\pm$ 0.041 centimeters long and 2.23 $\pm$ 0.018 centimeters wide. The selfed Giza 12 bolls measured 3.67 $\pm$ 0.028 centimeters long and 2.23 $\pm$ 0.019 centimeters wide; the unselfed, 3.72 $\pm$ 0.033 centimeters long and 2.28 $\pm$ 0.019 centimeters wide. In the case of the selfed Giza 19, the measurements of the bolls were 3.68 $\pm$ 0.021 centimeters long and 2.15 $\pm$ 0.017 centimeters wide; the unselfed, 3.69 $\pm$ 0.027 centimeters long and 2.22 $\pm$ 0.016 centimeters wide.

As shown in table 2, four different shapes of bolls were observed: these were conical, ovate-acuminate, orbicular-cuspidate, and orbicular-mucronate. In all varieties studied, the most common was ovate-acuminate, and the least common, orbicular-mucronate.

The number of locks per boll ranged from 3 to 4, three being the more common (fig. 5.) In a number of cases as in Giza 7 and Pima Egyptian Lot II, both grown from selfed and unselfed seeds, two locks per boll were observed. The persistence of the locks in the capsules was practically the same in all the varieties

studied. The locks were easily and completely removed from the capsules.

The seeds of the Pima Egyptian Lot I and Pima Egyptian Lot II whether grown from selfed or unselfed seeds were non-fuzzy, while those of the Gizas were, to a certain extent, fuzzy, being 9 per cent for selfed and 13 per cent for unselfed seeds of Giza 7, 8 per cent for both selfed and unselfed seeds of Giza 12, and 3 per cent for selfed and 4 per cent for unselfed seeds of Giza 19 (fig. 7).

To a slight degree the seeds of the Pima Egyptian plants of both lots had the tendency to become united, while those of the Gizas were free (fig. 12).

According to the data presented in table 3, the weights of bracts and capsules of both lots of the Pima Egyptian either from selfed or unselfed seeds were found to be greater than those of the Gizas. They were 1.54 ± 0.031 and 1.44 ± 0.025 grams for Pima Egyptian Lot I, 1.49 ± 0.026 and 1.53 ± 0.032 grams for Pima Egyptian Lot II, 1.22 ± 0.021 and 1.22 ± 0.025 grams for Giza 7, 1.32 ± 0.026 and 1.28 ± 0.027 grams for Giza 12, and 0.99 ± 0.019 and 0.90 ± 0.019 grams for Giza 19.

The Pima Egyptian Lot I and Pima Egyptian Lot II produced less lint per boll than the Gizas. This was due to the more seedy condition of the bolls of the Pima Egyptian plants of both lots as shown in table 4 as the percentage of seeds per boll was 41.50 ± 0.41 and 43.77 ± 0.45 for selfed and unselfed seeds of Pima Egyptian Lot I, 42.55 ± 0.35 and 41.72 ± 0.44 for Pima Egyptian Lot II, 38.93 ± 0.46 and 40.64 ± 0.27 for Giza 7, 37.51 ± 0.49 and 38.15 ± 0.50 for Giza 12, and 39.04 ± 0.49 and 37.97 ± 0.47 for Giza 19. As mentioned elsewhere in this paper, the bolls of the Pima Egyptian Lot I and Pima Egyptian Lot II, whether grown from selfed or unselfed seeds, were larger than those of the Gizas with one exception: the unselfed Pima Egyptian Lot II produced shorter bolls than the unselfed Giza 7.

According to the data presented in table 4, the fiber of the Pima Egyptian Lot I and Pima Egyptian Lot II was longer than that of the Gizas whether produced from selfed or unselfed seeds (fig. 6). The measurements were 2.89 ± 0.029 centimeters for selfed and 3.03 ± 0.030 centimeters for unselfed Pima Egyptian Lot I, 3.01 ± 0.022 centimeters for selfed and 3.09 ± 0.025 centimeters for unselfed Pima Egyptian Lot II, 2.34 ± 0.025 centimeters for selfed and 2.37 ± 0.024 centimeters for unselfed Giza 7, 2.42 ± 0.024 centi-

meters for selfed and 2.52 ± 0.022 centimeters for unselfed Giza 12, and 2.26 ± 0.022 centimeters for selfed and 2.15 ± 0.020 centimeters for unselfed Giza 19.

In regard to the color of the staple of the different varieties of cotton studied (table 4) the staples of the Pima Egyptian Lot I and Pima Egyptian Lot II, whether grown from selfed or unselfed seeds, were in general, found to be lighter than those of the Gizas, although the staples of the Pima Egyptian plants of both lots were longer, silkier, and glossier than those of the Gizas. The staples of the

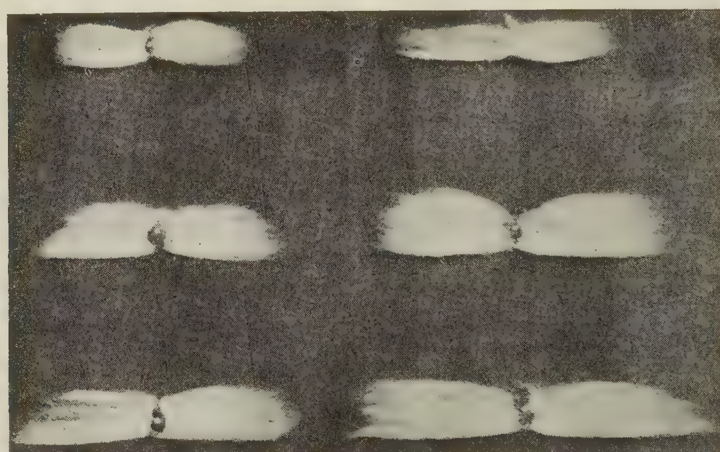

Fig. 6.—Lint of Pima Egyptian and of Giza varieties of cotton, showing comparative lengths. Left row shows lint of the Giza cotton of different lengths; short (top), medium (middle), and long (bottom). Right row shows lint of the Pima Egyptian cotton also of different lengths. Photograph by Star Studio, Los Baños, Laguna.

Gizas were more wooly than those of the Pima Egyptian Lot I and Pima Egyptian Lot II. The staple of Giza 19, grown from selfed or unselfed seeds, appeared to be the darkest in color. The staple of Pima Egyptian Lot II, both from selfed and unselfed seeds, appeared to be the lightest in color.

The actual and computed yields of the different varieties of cotton studied (table 5) whether grown from selfed or unselfed seeds, varied a great deal. The Pima Egyptian Lot I and Lot II were found to be heavier yielders for seed cotton than the Gizas whether they were grown from selfed or unselfed seeds. The computed yields of seeds cotton per hectare of the different varieties grown from selfed seeds were found to be 198.99 kgm. for Pima Egyptian Lot I,

248.06 kgm. for Pima Egyptian Lot II, 144.67 kgm. for Giza 7, 139.31 kgm. for Giza 12, and 167.84 kgm. for Giza 19. The yields of seed cotton grown from selfed seeds were 344.22 kgm. for Pima Egyptian Lot I, 440.70 kgm. for Pima Egyptian Lot II, 144.65 kgm. for Giza 7, 162.17 kgm. for Giza 12, and 207.68 kgm. for Giza 19. Of all the varieties grown from selfed seeds, Giza 19 gave the highest computed yield of lint per hectare, or 96.05 kgm. Other unselfed varieties gave computed yields of lint per hectare as follows: Pima Egyptian Lot II, 91.18. kgm.; Pima Egyptian Lot I, 74.56 kgm.; Giza 12, 72.23 kgm.; Giza 7, the poorest yielder, 70.09 kgm. The computed yield, 143.05 kgm., of lint per hectare of Pima Egyptian Lot I grown from unselfed seeds was higher than that of any other variety. Other varieties grown from unselfed seeds gave computed yields of lint per hectare as follows: 106.67 kgm. for Giza 19, 98.23 kgm. for Pima Egyptian Lot II, 88.99 kgm. for Giza 7, and 80.29 kgm. for Giza 12.

It is very interesting to note that the actual and computed yields of both seed cotton and lint were found to be greater in the case of those plants grown from unselfed seeds than those grown from selfed ones, except in the case of Giza 7, where the selfed was a somewhat higher yielder of seed cotton than the unselfed, although the difference was very slight. This difference in yield between the plants grown from selfed and unselfed seeds was due to the fact that those plants grown from unselfed seeds were found to be more vigorous and had a better stand in the field than those grown from selfed seeds. Vigor, as observed in the unselfed seed is an indication of natural hybridity due to vicinism.

As shown in table 6, those cotton plants of Pima Egyptian Lot I and Pima Egyptian Lot II which were grown from selfed seeds produced no off-types or vicinists. On the other hand, those selfed seeds of Giza 7 produced 3.8 per cent; Giza 12, 2.6 per cent; and Giza 19, 1.3 per cent of vicinists.

The cotton plants of Pima Egyptian Lot I produced 3.3 per cent and Pima Egyptian Lot II, 4.4 per cent of vicinists in their unselfed progeny. On the other hand, the unselfed progeny of Giza 7 gave 2.7 per cent; Giza 12, 1.2 per cent; and Giza 19, 3.1 per cent of vicinists.

The percentage of vicinists or off-type in the selfed Gizas and in the unselfed Pima Egyptian Lot I and Pima Egyptian Lot II was based on the number of cotton plants which showed pale cendre green petal, almost or completely spotless petals, creamy anther color, and

bolls with midlock furrows. A typical Pima Egyptian and Giza flower had a yellow petal, orange yellow anther with a dark distinct purple claw, and produced bolls without midlock furrows.

The percentage of vicinists in the unselfed Giza varieties was based on the number of plants which produced fuzzy seeds. Typical Giza seeds were not fuzzy (fig. 7).

The fact that the selfed Pima Egyptian Lot I and Pima Egyptian Lot II did not produce any off-type while the unselfed had certain

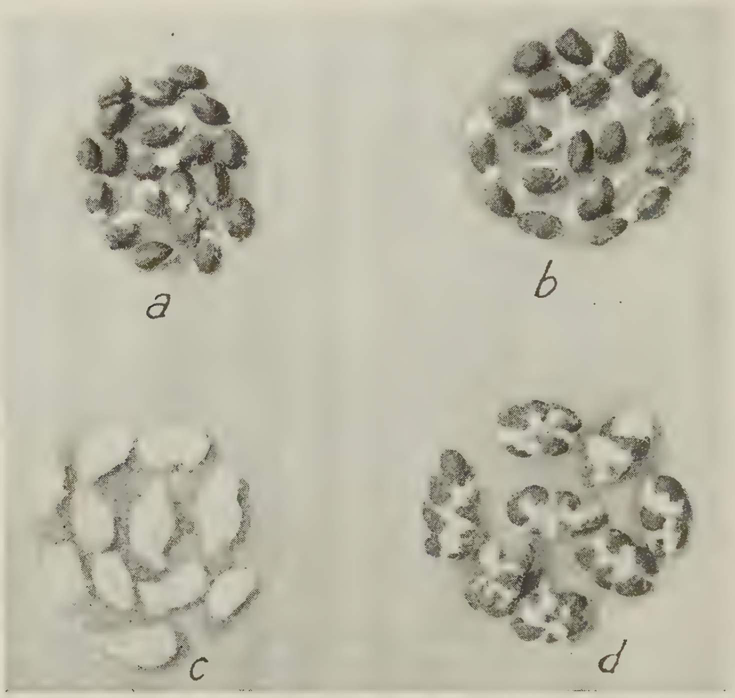

Fig. 7.—Seeds of Pima Egyptian and of Giza varieties of cotton. *a*, typical seeds of Giza, separate and non-fuzzy; *b*. typical seeds of the Pima Egyptian Lot I and Pima Egyptian Lot II, separate and non-fuzzy; *c*, Giza cotton seeds with fuzz; and *d*, Pima Egyptian cotton seeds, united together. Photograph by Star Studio, Los Baños, Laguna.

percentages of vicinists (table 6) shows that the original stock of the imported Pima Egyptian seeds was of a homozygous progeny and that the presence of vicinists in the unselfed Pima Egyptian was the effect of natural crossing occurring locally. The presence of certain percentages of vicinists found in both selfed and unselfed Gizas, accounted for by fuzziness of seeds as a criterion, leads one to believe that the introduced seeds of the Gizas were of a heterozygous progeny,

resulting from the effect of crossing, natural or artificial, that has occurred elsewhere before the introduction. The fact that Giza 12 and Giza 19 either grown from selfed or unselfed seeds did not produce any off-type flowers further indicates that close-pollination rather than cross pollination generally occurred.

Of the varieties studied, the selfed Pima Egyptian Lot I and Pima Egyptian Lot II seeds were found to be more consistent in their state of being homozygous as they did not produce any vicinist. This result confirms the statement of Kearney (1921), who worked on heritable variation in Pima Egyptian cotton in Arizona, that the "Pima Egyptian is probably the most uniform variety of cotton now grown on an extensive scale".

Table 6 shows that whenever vicinists were found in the field, it was observed that pale cendre green petals were always followed by creamy anthers, almost spotless or entirely spotless petals, and bolls with midlock furrows.

SUMMARY AND CONCLUSIONS

1. The bolls of the Pima Egyptian cotton plants of both lots were larger than the Gizas, except that the unselfed Giza 7 had longer bolls than the unselfed Pima Egyptian Lot II.

2. The bolls produced by both lots of Pima Egyptian were conical, ovate-acuminate, and orbicular-cuspidate, while those of the Gizas were conical, ovate-acuminate, orbicular-cuspidate, and orbicular-mucronate. In all of the varieties studied, the most typical shape of the boll was ovate-acuminate and the least typical, orbicular-mucronate (fig. 4).

3. The number of locks per boll ranged from 2 to 4; three was the most common. Two locks per boll were observed in a few cases (Giza 7 and Pima Egyptian Lot II).

4. The Gizas were less seedy than the Pima Egyptian of both lots. The seeds of the Pima Egyptian Lot I and Pima Egyptian Lot II were not fuzzy, while those of the Gizas were, to a certain extent, fuzzy. Some seeds of the Pima Egyptian plants of both lots were united, while those of the Gizas were free. The vicinists of all the Gizas, selfed or unselfed, produced fuzzy seeds.

5. Although the fiber of the Pima Egyptian Lot I and Pima Egyptian Lot II was longer, finer, glossier, and had a lighter color, the amount produced per boll was less than that of the Gizas.

6. For seed cotton, the Pima Egyptian of both lots were heavier yielders than the Gizas. The yield of lint was highest in the case of

Pima Egyptian Lot I, second highest in Giza 19, and third in Pima Egyptian Lot II. The poorest yielders were Giza 7 and Giza 12.

7. Cotton plants grown from unselfed seeds produced greater yield of both lint and seed cotton than selfed ones. They were more vigorous and had a better stand in the field.

8. The Pima Egyptian plants grown from selfed seeds produced no vicinists. In each of the varieties studied there was a small percentage of vicinists not reaching 5 per cent in any variety. The vicinists from the unselfed Pima Egyptian plants of both lots and those of the selfed Giza 7 produced flowers with pale green corolla, spotless or almost spotless petals, creamy anther, and bolls with midlock furrows.

LITERATURE CITED

BAILEY, M. A., AND T. TROUGHT. 1926. The development of the Egyptian cotton plant. Min. Agric. Egypt Tech. Sci. Serv. Bull. 60: 1–46.

BALLS, W. L. 1912. The cotton plant in Egypt. xvi + 202 p., 52 fig. London: Macmillan Company.

COOK, O. F. 1909. Local adjustment of cotton varieties. U. S. Dept. Agric., Bur. Plant Ind. Bull. 159: 1–75.

KEARNEY, T. H. 1913. Seed selection of Egyptian cotton. U. S. Dept. Agric. Bull. 38: 1–8.

KEARNEY, T. H. 1914. Mutation in Egyptian cotton. Jour. Agric. Res. 2: 287–302. pl. 1–11.

KEARNEY, T. H. 1921. Heritable variations in an apparently uniform variety of cotton. Jour. Agric. Res. 21: 227–242. Pl. 48–54.

KEARNEY, T. H. 1923. Self fertilization and cross fertilization in Pima cotton. U. S. Dept. Agric. Bull. 1134: 1–68. Pl. 1–9, fig. 1–4.

KING, C. J. 1922. Water stress behavior of Pima cotton in Arizona. U. S. Dept. Agric. Bull. 1018: 1–24. Pl. 1–4, fig. 1–3.

TABLE 1

Period of maturity of reproductive organ and rate of shedding of bolls of different varieties grown from selfed and unselfed seeds

VARIETY	DATE OF PLANTING	APPEARANCE			MATURITY OF BOLLS	BOLL SHEDDING		COLOR OF PETAL	
		Square	Flower	Bolls		Number of bolls shed	Average age	Before opening	After opening
selfed		*days*	*days*	*days*	*days*		*days*		
Pima Egyptian Lot I .	Oct. 22, 1936	59.1	90.5	94	152.8	183	3	Martius yellow Picric yellow Pinard yellow Pale lemon yellow Lemon yellow	Sulphur yellow Pale green yellow Light green yellow Pale greenish yellow
Pima Egyptian Lot II .	" " "	58.4	84.1	87	145.6	232	10		
Giza 7	" " "	58.9	90.3	93	152.4	154	6	Pale greenish yellow Martius yellow Pinard yellow Picric yellow Pale lemon yellow	Light viridine green Sulphur yellow Pale green yellow Light green yellow
Giza 12	" " "	53.5	85.2	88	147.0	168	12		
Giza 19	" " "	61.5	84.5	88	150.9	197	11		
unselfed									
Pima Egyptian Lot I .	Oct. 23, 1936	55.2	84.9	88	146.9	152	9	Martius yellow Pinard yellow Picric yellow Pale lemon yellow Lemon yellow	Light viridine yellow Sulphur yellow Pale green yellow Light green yellow Pale greenish yellow
Pima Egyptian Lot II .		56.5	87.6	91	149.9	161	9		
Giza 7	" " "	57.1	88.7	92	155.1	177	8	Pale greenish yellow Martius yellow Pinard yellow Picric yellow Pale lemon yellow	Light viridine green Sulphur yellow Pale green yellow Light green yellow
Giza 12	" " "	60.6	86.8	90	153.2	219	14		
Giza 19	" " "	58.6	89.2	92	155.2	170	8		

TABLE 2

Morphological and agronomic characteristics of bolls of different varieties of cotton grown from selfed and unselfed seeds

VARIETY	SELFED								
	Size		Shape				Ave. no. of locks per boll	Percentage of bolls with fuzzy seeds	Percentage of bolls with seeds united
	Length	Diameter	Conical	Ovate-acuminate	Orbicular-cuspidate	Orbicular-mucronate			
	cm.	*cm.*	*per cent*	*per cent*	*per cent*	*per cent*			
Pima Egyptian Lot I	4.51 ± 0.039	2.34 ± 0.020	10.0	83.0	7.0	0	3.08	0	4.0
Pima Egyptian Lot II	4.10 ± 0.037	2.28 ± 0.021	11.0	80.0	9.0	0	3.11	0	6.0
Giza 7	4.06 ± 0.030	2.18 ± 0.014	2.0	43.0	10.0	10.0	3.04	9.0	0
Giza 12	3.67 ± 0.028	2.23 ± 0.019	3.0	37.0	42.0	18.0	3.04	8.0	0
Giza 19	3.68 ± 0.021	2.15 ± 0.017	2.0	49.0	38.0	11.0	3.06	3.0	0

VARIETY	UNSELFED								
	Size		Shape				Ave. no. of locks per boll	Percentage of bolls with fuzzy seeds	Percentage of bolls with seeds united
	Length	Diameter	Conical	Ovate-acuminate	Orbicular-cuspidate	Orbicular-mucronate			
	cm.	*cm.*	*per cent*	*per cent*	*per cent*	*per cent*			
Pima Egyptian Lot I	4.36 ± 0.036	2.37 ± 0.0206	13.0	81.0	6.0	0	3.04	0	3.0
Pima Egyptian Lot II	4.02 ± 0.040	2.30 ± 0.0281	13.0	77.0	10.0	0	3.14	0	5.0
Giza 7	4.26 ± 0.041	2.23 ± 0.0181	4.0	42.0	46.0	8.0	3.11	13.0	0
Giza 12	3.72 ± 0.033	2.28 ± 0.0188	1.0	45.0	42.0	12.0	3.03	8.0	0
Giza 19	3.69 ± 0.027	2.22 ± 0.0166	3.0	46.0	39.0	12.0	3.03	4.0	0

TABLE 3

Relative percentage of the different parts of the bolls of different varieties of cotton grown from selfed and unselfed seeds

VARIETY	BRACTS AND CAPSULES		LINT		SEEDS		WEIGHT OF BOLL
	grams	*per cent*	*grams*	*per cent*	*grams*	*per cent*	*grams*
selfed							
Pima Egyptian Lot I	1.54 ± 0.031	42.95 ± 0.570	0.57 ± 0.015	15.55 ± 0.285	1.53 ± 0.036	41.50 ± 0.411	3.64 ± 0.069
Pima Egyptian Lot II	1.49 ± 0.026	41.81 ± 0.462	0.57 ± 0.014	15.64 ± 0.276	1.57 ± 0.035	42.55 ± 0.351	3.63 ± 0.065
Giza 7	1.22 ± 0.021	42.20 ± 0.458	0.55 ± 0.011	18.86 ± 0.248	1.14 ± 0.024	38.93 ± 0.463	2.19 ± 0.44
Giza 12	1.32 ± 0.026	43.04 ± 0.603	0.63 ± 0.031	19.45 ± 0.360	1.21 ± 0.032	37.51 ± 0.492	3.15 ± 0.057
Giza 19	0.99 ± 0.019	38.52 ± 0.506	0.58 ± 0.012	22.34 ± 0.317	1.02 ± 0.024	39.04 ± 0.491	2.59 ± 0.044
unselfed							
Pima Egyptian Lot I	1.44 ± 0.025	38.06 ± 0.481	0.69 ± 0.016	18.19 ± 0.308	1.71 ± 0.037	43.77 ± 0.452	3.84 ± 0.069
Pima Egyptian Lot II	1.53 ± 0.032	42.56 ± 0.538	0.57 ± 0.013	15.72 ± 0.181	1.55 ± 0.041	41.72 ± 0.438	3.65 ± 0.074
Giza 7	1.22 ± 0.025	38.18 ± 0.520	0.68 ± 0.014	21.18 ± 0.241	1.31 ± 0.027	40.64 ± 0.273	3.21 ± 0.055
Giza 12	1.28 ± 0.027	42.64 ± 0.657	0.59 ± 0.016	19.09 ± 0.352	1.18 ± 0.025	38.15 ± 0.496	3.05 ± 0.048
Giza 19	0.90 ± 0.019	39.33 ± 0.673	0.55 ± 0.013	23.36 ± 0.435	0.88 ± 0.022	37.97 ± 0.472	2.33 ± 0.036

TABLE 4

Characteristics of fiber of different varieties of cotton grown from selfed and unselfed seeds

VARIETY	LENGTH	COLOR	SILKINESS	TEXTURE
selfed	*cm.*			
Pima Egyptian Lot I	2.89 + 0.029	Creamy white with a tint of cartridge buff, cream buff and tilleul buff	Silky and glossy	Very fine and smooth with considerable neps
Pima Egyptian Lot II	3.01 + 0.022	Light creamy white with a tint of cartridge buff, and cream buff and patches of colonial buff	Very silky glossy	Very fine and smooth with considerable neps
Giza 7	2.34 + 0.025	Creamy white with a tint of cartridge buff and tilleul buff and patches of tilleul buff and cinnamon buff	Silky and glossy	Very fine and smooth with considerable neps
Giza 12	2.42 + 0.024	Creamy white with a tint of pale pinkish cinnamon, pale cinnamon pink and cream buff and cinnamon buff	Silky and shiny	Fine and smooth with considerable neps
Giza 19	2.26 + 0.022	Dull creamy white with a tint of pale cinnamon pink and tilleul buff with patches of cream buff, colonial buff and chamois	Silky and shiny	Fine and smooth with considerable neps
unselfed				
Pima Egyptian Lot I	3.03 + 0.030	Light creamy white with tint of cartridge buff and cream buff	Very silky and glossy	Very fine smooth with considerable neps
Pima Egyptian Lot II	3.09 + 0.025	Creamy white with a tint buff and cream with patches of colonial buff	Very silky and glossy	Very fine and smooth with considerable neps
Giza 7	2.37 + 0.024	Light creamy white with a tint of cartridge buff and cream buff and patches of tilleul buff	Silky and glossy	Very fine smooth and with considerable neps
Giza 12	2.52 + 0.022	Creamy white with a tint of pale pinkish cinnamon pale cinnamon pink, and cream buff, and patches of winter green and cinnamon buff	Silky and shiny	Fine and smooth with considerable neps
Giza 19	2.15 + 0.020	Dull creamy white with a tint of pale cinnamon pink and tilleul buff and patches of cream buff and colonial buff	Silky and shiny	Fine and smooth with considerable neps

TABLE 5

Actual and computed yields of seed cotton and lint of different varieties of cotton grown from selfed and unselfed seeds

VARIETY	SELFED				UNSELFED			
	YIELD OF SEED COTTON		YIELD OF LINT		YIELD OF SEED COTTON		YIELD OF LINT	
	Actual	Computed per hectare	Actual	Computed per hectare	Actual	Computed per hectare	Actual	Computed per hectare
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Pima Egyptian Lot I	19.900	198.99	7.456	74.56	34.422	344.22	14.303	143.05
Pima Egyptian Lot II	24.806	248.06	9.118	91.18	26.070	260.70	9.823	98.23
Giza 7	14.467	144.67	7.009	70.09	14.465	144.65	8.899	88.99
Giza 12	13.931	139.31	7.223	72.23	16.217	162.17	8.029	80.29
Giza 19	16.784	167.84	9.605	96.05	20.668	204.68	10.667	106.67

TABLE 6

Relative percentage of vicinists observed in the different varieties of cotton grown from selfed and unselfed seeds [a]

VARIETY	SELFED						UNSELFED					
	Petal color	Anther color	Clawless or almost clawless petals	Character of midlock furrow	Fuzzy seed	Total percentage of vicinists	Petal color	Anther color	Clawless or almost clawless petals	Character of midlock furrow	Fuzzy seed	Total percentage of vicinists
Pima Egyptian Lot I	0	0	0	0	0	0	3.3	3.3	3.3	3.3	0	3.3
Pima Egyptian Lot II	0	0	0	0	0	0	4.4	4.4	4.4	4.4	0	4.4
Giza 7	2.2	2.2	2.2	2.2	1.6	3.8	0	0	0	0	2.7	2.7
Giza 12	0	0	0	0	2.6	2.6	0	0	0	0	1.2	1.2
Giza 19	0	0	0	0	1.3	1.3	0	0	0	0	3.1	3.1

[a] Pale flowers were observed always to have almost clawless petals and creamy anthers and to produce bolls with midlock furrows.

THE LOS BAÑOS BIOLOGICAL CLUB: (1933-1940 SUMMARY OF ACHIEVEMENTS)[1]

Since the organization of the Los Baños Biological Club on November 23, 1923, three papers (Anonymous, 1925, Fronda, 1927, and Manresa, 1934) have been published on the history and activities of the club. The last paper by Manresa (1934) records the signal accomplishments of the Club in the short span of ten years, from November, 1923 to October, 1933. The present paper was prepared to summarize and bring the records up to date.

OFFICERS AND SCIENTIFIC MEETINGS

According to the unwritten constitution of the Club, the officers shall be a president and a secretary who will handle the details of its work. These officers shall hold office for one school year. No officer who has served his full term can be reelected. The first scientific meeting was held on December 4, 1923, and since then scientific meetings have been held regularly each month except in April and May. The names of the officers, the number of scientific meetings, and the number of papers read since the foundation of the Club to March, 1940, may be seen in table 1.

DEPARTMENTAL CONTRIBUTIONS TO SCIENTIFIC PROGRAMS

The faculty members in the various departments of the College of Agriculture, College of Veterinary Science, and the School of Forestry located at Los Baños who are interested in biological science constitute the active members and the contributors of scientific papers for the scientific meetings of the Club.

Table 2 shows the number of papers contributed by the different departments of the three institutions. Appended to the table is the list of papers read before the Club from December, 1933 to March, 1940. It is gratifying to report that after many years of effort, copies of these papers have been collected, bound, and filed in the library of the College of Agriculture.

List of papers read before the Club from December, 1933 to March, 1940. (*For papers read from December, 1923 to October, 1933, see Manresa, 1934*).

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[1] General contribution No. 738.

Department of Agricultural Botany

1. Dr. J. B. JULIANO. Studies on the morphology of the Meliaceae: II. Sterility in santol. December, 1933.
2. Dr. J. B. JULIANO. The anatomy and morphology of the 'bunga' *Aeginetia indica* Linn. August, 1934.
3. Dr. R. B. ESPINO AND Mr. F. PANTALEON. Effects of heat upon the viability of 'bunga' seeds, *Aeginetia indica* Linn. August, 1934.
4. Dr. RAFAEL B. ESPINO. Impressions from a recent trip to China. June, 1935.
5. Dr. R. B. ESPINO. Construction of mushroom beds in southern China. November, 1935.
6. Dr. J. B. JULIANO AND Dr. E. QUISUMBING. Floral mechanism in *Sterculia apetala* (Jacq.) Karsten (*Sterculia carthaginensis* Cav.). September, 1936.
7. Mr. R. P. ESTIOKO. Weather observations at the College of Agriculture during 1924-1937. August, 1938.
8. Mr. F. PANTALEON. What would be the ultimate effects upon the growth and yields of rice plants of rice straw and rice straw ash, or both, when added to Lipa clay loam at different times. September, 1938.
9. Dr. R. B. ESPINO. Studies on the fertilizing value of Mayon Volcano ash: I. Effects upon plants of liberal application of the volcanic ash. November, 1938.
10. Dr. R. B. ESPINO. Chemical fertilizers used in various sugar centrals in the Philippines. January, 1939.
11. Dr. R. B. ESPINO. Studies on the fertilizing value of Mayon Volcano ash: II. Beneficial effects of adding ammonium sulfate. June, 1939.
12. Dr. J. B. JULIANO. A study of the growth habit of rice plants: IV. Locality and grain. October, 1939.

Department of Agricultural Chemistry

1. Dr. G. A. GUANZON. Clarification and preservation of toddy. September, 1934.
2. Mr. J. BANZON. Studies on the thermal decomposition of coconut oil. November, 1934.
3. Mr. L. J. VILLANUEVA AND Mr. H. E. LUMANG. Carbon-nitrogen ratios of some Philippine soils. February 1935.
4. Mr. F. A. SOLIVEN AND Dr. A. I. DE LEON. Extraction of coconut oil—bacterial process. February, 1936.
5. Mr. JULIAN BANZON. On the measurement of velocity of reaction between coconut oil and ethyl alcohol. March, 1936.
6. Dr. F. O. SANTOS, Mr. E. IGNACIO, AND Mr. JOSE SILVA. On the foods of the families of Sta. Catalina, Ilocos Sur; Paoay, Ilocos Norte; and Pototan, Iloilo. August, 1936.
7. Dr. F. O. SANTOS. Studies on the plane of nutrition of families of laborers in Calabañga, Camarines Sur. February, 1937.

8. Mr. JULIAN BANZON. A method for resinifying vegetable oils. March, 1937.
9. Mr. M. R. MONSALUD. A new transplanting tool. October, 1937.
10. Dr. F. O. SANTOS AND Mr. E. M. GALVEZ. Studies on the foods served by seven restaurants to students of the College of Agriculture. February, 1938.
11. Dr. A. I. DE LEON AND Mr. F. T. AGDEPPA. The hydrogenation of mixed oils. March, 1938.
12. Dr. F. O. SANTOS AND Mr. J. K. DEMETERIO. Studies on the food of 121 families of laborers in Macrohon, Leyte. August, 1938.
13. Mr. M. R. MONSALUD. The making of soft drinks. October, 1938.
14. Dr. F. O. SANTOS AND Dr. P. S. HAMOY. The food of 158 families in Ramain, Lanao. January, 1939.
15. Dr. F. O. SANTOS. Attendance to the Sixth Pacific Science Congress. October, 1939.
16. Mr. M. R. MONSALUD. The preparation of alcoholic beverages and liquors. December, 1939.
17. Dr. A. I. DE LEON AND Mr. R. SAMANIEGO. Activated carbon from agricultural waste products. February, 1940.

Department of Agricultural Economics

1. Dr. PABLO N. MABBUN. Some problems connected with our future foreign trade. February, 1936.
2. Prof. J. E. VELMONTE. An analysis of the report of the Joint Preparatory Committee on Philippine Affairs. January, 1939.
3. Mr. M. V. ARNALDO AND Prof. J. E. VELMONTE. A five-year farm accounting study of tenancy on the College of Agriculture Farm. 1931-1936. September, 1939.

Department of Agricultural Education

1. Mr. F. BARROS. A comparative study of the effects on the yield of corn of some leguminous crops used as green manure. February, 1940.

Department of Agricultural Engineering

1. Dr. A. L. TEODORO. Effects of pre-heating on the operation of a high compression tractor engine using alcohol and alcohol-gasoline blends as fuels. December, 1933.
2. Mr. E. M. BAUTISTA. A study of grading and combining aggregates to obtain maximum voids for concrete work. December, 1934.
3. Dr. A. L. TEODORO, Prof. A. B. CATAMBAY, Mr. E. M. ONGSANSOY, AND Mr. J. P. MAMISAO. Performance characteristics of alcohol, alcohol-gasoline blends, and gasoline as motor fuels under different road conditions. March, 1935.
4. Prof. A. B. CATAMBAY AND Mr. N. L. CUEVAS. Comparative cost of operation of a Fordson tractor using kerosene and alcohol as motor fuels. August, 1935.

5. Dr. A. L. TEODORO. Studies on the performance of an eight cylinder engine using gasoline, dehydrated alcohol, and dehydrated alcohol-gasoline mixture. November, 1935.
6. Dr. A. L. TEODORO AND Mr. E. K. ONGSANSOY. Alcohol and alcohol-gasoline blends as fuels for automobile engines. VI. Studies on the use of alcohol-gasoline mixtures as fuels for a high compression eight cylinder automobile engine. July, 1936.
7. Dr. A. L. TEODORO AND Mr. J. P. MAMISAO. Corrosion of metal by motor fuel. July, 1937.
8. Dr. A. L. TEODORO. Fifty thousand kilometers on alcohol as motor fuel. February, 1939.

Department of Agronomy

1. Mr. T. MERCADO. A new juice squeezer for preharvest analysis. January, 1934.
2. Dr. E. P. BALTAZAR. The use of chemicals in curing and fermenting tobacco. February, 1934.
3. Dr. L. G. GONZALEZ. Methods of propagation of the macopa, *Eugenia javanica,* with special reference to the use of other species as stocks. June, 1934.
4. Dr. N. B. MENDIOLA, Dr. J. M. CAPINPIN, AND Mr. T. MERCADO. Twelve years of improvement of Philippine pineapple in the College of Agriculture. June, 1934.
5. Dr. L. G. GONZALEZ. Topworking undesirable santol trees. July, 1934.
6. Mr. A. SAN PEDRO. Preliminary studies on the marcottage of the avocado. October, 1934.
7. Dr. N. B. MENDIOLA. The introduction of Nepheliums in the College of Agriculture from Java. October, 1934.
8. Dr. V. C. CALMA. Experiments on harvesting of sugar cane. December, 1934.
9. Dr. J. M. CAPINPIN. A genetic study of certain characters in varietal hybrids of cowpea, *Vigna sinensis* Endl. January, 1935.
10. Dr. V. C. CALMA, Mr. C. VALERA, AND Mr. L. NUESTRO. Studies of different kinds of seed pieces for commercial propagation of sugar cane. March, 1935.
11. Dr. J. M. CAPINPIN. Hybridization and selection of cotton varieties. June, 1935.
12. Dr. V. C. CALMA AND Mr. A. V. ANDAM. A preliminary study of the comparative effects of fertilizing with ammonium sulfate and green manure upon the yields of sugar cane. August, 1935.
13. Mr. A. V. SAN PEDRO. Flower behavior of avocados in the College of Agriculture with special reference to some promising varieties. September, 1935.
14. Dr. L. G. GONZALEZ. The use of inarching to improve rate of propagation by grafting and marcottage. December, 1935.
15. Prof. A. B. CATAMBAY. Cost of production of cassava in the College of Agriculture. October, 1936.
16. Dr. J. M. CAPINPIN. Studies on biotypes of Philippine corn. January, 1937.

17. Dr. N. B. MENDIOLA. A search for hidden and traumatic bud variations in sweet potato. January, 1937.
18. Dr. V. C. CALMA. Variety tests of sugar cane. February, 1937.
19. Dr. L. G. GONZALEZ. Observations on intra- and inter-generic grafting of some fruit trees. March, 1937.
20. Dr. V. C. CALMA. The comparative effects of ammonium sulfate and different legumes as green manure upon the yield of sugar cane. August, 1937.
21. Dr. N. B. MENDIOLA. Propagation under cultivation of wild plants protected under Act, No. 3893. September, 1937.
22. Mr. C. E. YANGO. Does corn shelling by machine affect germination? October, 1937.
23. Mr. V. M. DAWIS. Variability among plants of *Anthurium crystallinum* produced from seeds. November, 1937.
24. Dr. J. M. CAPINPIN. A lethal-linked kernel variation in Lagkit corn. December, 1937.
25. Prof. V. B. ARAGON AND Mr. E. CADA. A preliminary report on the performance of ten varieties of Federated Malay States rices. June, 1938.
26. Dr. P. A. DAVID. Ramic and its cultivation in Davao. October, 1938.
27. Mr. T. MERCADO. A comparative study of two bud sports of cassava and their parent varieties. November, 1938.
28. Dr. V. C. CALMA. Studies on the manufacture and uses of rimas flour. December, 1938.
29. Dr. N. B. MENDIOLA. On the nature of hidden bud variations. March, 1939.
30. Dr. L. G. GONZALEZ. Report on a recent trip to Java and Bali. July, 1939.
31. Dr. V. C. CALMA AND Dr. L. G. GONZALEZ. Studies on different containers for potting fruit plants. August, 1939.
32. Dr. N. B. MENDIOLA. Interspecific crossing in Artocarpus, a hindrance to acclimatization and propagation of *A. champeden*. September, 1939.
33. Mr. C. E. YANGO. A study of two methods of planting corn: with a corn planter and by hand. November, 1939.
34. Mr. V. M. DAWIS. A study of the relation between length of storage of corms and maturity and yields of gladiolus. December, 1939.
35. Dr. J. M. CAPINPIN. Statistical interpretation of experimental results in biological and agricultural research. January, 1940.

Department of Animal Husbandry

1. Mr. NICOMEDES C. REYES. Studies on the blood of different breeds of cattle with special reference to adaptability to local conditions. March, 1934.
2. Dr. F. M. FRONDA AND Mr. D. D. CLEMENTE. Studies on the physical qualities of the hen's egg: I. Observations on new-laid Los Baños Cantonese eggs. June, 1934.
3. Dr. F. M. FRONDA AND Mr. A. E. KABIGTING. Protein supplements in poultry rations: III. The optimum amount of shrimp meal to use as supplements in rations for growing chicks. November, 1934.

4. Dr. M. Manresa and Dean B. M. Gonzalez. Studies on surra. II. Natural recovery from surra infestation among taurine and bubaline species of cattle. February, 1935.
5. Dr. M. Manresa and Mr. O. Mondoñedo. Studies on surra. III. A survey on the incidence of surra in the vicinity of the College of Agriculture with observations on numerical fluctuations of Tabanid flies. June, 1935.
6. Dr. F. M. Fronda. Observations on the effect of some storms on egg production. July, 1935.
7. Dr. B. M. Gonzalez. The development of Philippine agriculture during the American regime. July, 1935.
8. Dr. V. Villegas and Mr. L. A. Ynalvez. The fertilizing constituents in the solid excreta of sheep and goats. November, 1935.
9. Dr. M. Manresa and Dr. B. M. Gonzalez. Studies on surra IV: Variability in size of trypanasomes, natural recovery, and immunity from surra, natural and acquired. January, 1936.
10. Dr. M. Manresa and Dr. M. Mondoñedo. Berkjala pigs. June, 1936.
11. Dr. F. M. Fronda, Mr. F. T. Bañez, and Mr. G. A. Monegas. The influence of withholding feeds from newly hatched chicks. August, 1936.
12. Dr. F. M. Fronda and Mr. D. D. Clemente. Studies on the physical qualities of hen's egg: V. Age and seasonal changes as factors in the rate of deterioration of the interior quality of Los Baños Cantonese eggs. November, 1936.
13. Dr. V. Villegas, Mr. L. A. Ynalvez, and Mr. A. Elepaño. A comparative study of the amount of feces voided by Philippine Nellore cattle and the fertilizing constituent contained therein. September, 1936.
14. Mr. E. Basio. Observations on pigmentation in Los Baños Cantonese pullets. January, 1937.
15. Dr. M. Manresa. Animal Husbandry in India. II: The influence of temperature upon European breeds of dairy cattle in India. June, 1937.
16. Dr. F. M. Fronda and Mr. E. Basio. Ducks in battery laying cages. September, 1937.
17. Dr. V. Villegas. The livestock industries of Cochin China, Cambodia, Siam, and Malaya. July, 1938.
18. Dr. M. Manresa, Mr. N. Pepito and Mr. A. L. Silva. The comparative efficiency of pasture improvement methods. September, 1938.
19. Dr. M. Mondoñedo. Cost of production of pigs at the College of Agriculture. December, 1938.
20. Dr. F. M. Fronda, and Mr. R. Evangelista. Smoked ducks and how to prepare them. March, 1939.
21. Dr. V. Villegas. The birth weights of horses, cattle, and carabaos and their relation to weight. June, 1939.
22. Dr. M. Manresa. Animal breeding methods used in the formation of cattle suitable for raising in the tropics. July, 1939.
23. Mr. J. P. Esguerra. The cost of production of corn silage at the College of Agriculture. August, 1939.
24. Mr. L. P. Zialcita and Dr. F. M. Fronda. Observations on the normal hemoglobin content of the Los Baños Cantonese chicken. December, 1939.

Department of Entomology

1. Dr. L. B. Uichanco. Tolerance of mealy bugs to drying of host tissue. October, 1934.
2. Dr. L. B. Uichanco. The bearing of certain astronomical phenomena on locust outbreaks in the Philippines. March, 1936.
3. Dr. L. B. Uichanco. A report on a recent trip to Mindanao. September, 1936.
4. Dr. S. M. Cendaña and Mr. A. M. Mane. A preliminary study on the distribution of fresh water mollusks in Laguna de Bay. October, 1936.
5. Dr. S. M. Cendaña and Mr. A. M. Mane. Recent physical changes in Laguna de Bay and their effects on the lake fauna. July, 1937.
6. Dr. L. B. Uichanco. Insects in Philippine folklore. August, 1937.
7. Dr. L. B. Uichanco. A report on two recent international scientific congresses. February, 1939.
8. Dr. S. M. Cendaña and Mr. D. V. Fermin. Biology of *Kaloula picta* (Dumerial et Bibron) with special reference to its development and breeding habits. November, 1939.

Department of Plant Pathology

1. Mr. M. S. Celino. Sclerotium disease of cotton. August, 1935.
2. Mr. E. F. Roldan. Preliminary trials on soil disinfection with formaldehyde and acetic acid dusts for control of damping-off of seedlings. September, 1935.
3. Dr. G. O. Ocfemia, Mr. I. C. Manzo, and Mr. M. S. Celino. The gum disease of citrus in the Philippines. January, 1936.
4. Dr. G. O. Ocfemia. The abacá-disease situation in Davao. June, 1937.
5. Mr. E. F. Roldan. Mosaic disease of some crucifers. June, 1938.
6. Mr. R. F. Roldan and Mr. A. F. Querijero. Black spot of peanut. November, 1938.
7. Dr. G. O. Ocfemia. Attendance to the Sixth Pacific Science Congress. October, 1939.

Department of Soils

1. Dr. R. P. Pendleton. Soils surveying in China. March, 1934.
2. Dr. D. I. Aquino. A study of base exchange properties of certain Philippine soils. June, 1936.
3. Dr. N. Galvez. Plant-food reserve in lowland and upland soils. July, 1936.
4. Dr. N. Galvez. On the physical and chemical properties of white soil in Mt. Maquiling, Los Baños, Laguna. February, 1937.
5. Dr. N. Galvez. Citric acid as a reagent in the gravimetric method of determining soil iron in hydrochloric acid solution. November, 1937.
6. Dr. N. Galvez. The chemical and physical composition of the fine ejecta of Mayon Volcano. September, 1938.
7. Dr. N. Galvez, Dr. D. Aquino and Mr. J. P. Mamisao. The agricultural value of fine ejecta of Mayon Volcano. October, 1938.

School of Forestry

1. Mr. M. Sulit. Notes on medicinal plants in the Maquiling National Park and its vicinity. January, 1934.

2. Mr. J. Seguerra. Study of the clear length of Molave (*Vitex paviflora* Juss.) trees in stand. February, 1934.
3. Mr. R. Buhay. Comparative resistance of some treated and untreated American woods against termites and decay. March, 1934.
4. Mr. J. Seguerra. Study of diameter growth of eight species in the Maquiling National Park. September, 1934.
5. Mr. N. Lalog. Financial results of an ipil-ipil plantation. December, 1934.
6. Mr. Mamerto Sulit. Notes on poisonous plants in Mt. Maquiling and vicinity. January, 1935.
7. Mr. J. S. Ilustrisimo and Mr. F. O. Chinte. Development of heartwood in lanutan and narra. September, 1935.
8. Mr. J. Seguerra. Preliminary line-plot system in the culled Dipterocarp forest, Maquiling National Park. December, 1935.
9. Mr. Mamerto Sulit. Wild ornamental plants in the Philippine Islands. June, 1936.
10. Prof. P. Dacanay. Some forestry problems in the Philippines. October, 1936.
11. Mr. J. Seguerra. Diameter increment of trees in the natural stand, Maquiling National Park. November, 1936.
12. Dr. F. M. Salvoza. The dipterocarp in Pañgil, Laguna. June, 1937.
13. Mr. J. Seguerra. The solid wood content of stacked ipil-ipil firewood and its heating value. September, 1937.
14. Mr. M. Sulit. Notes on some poisonous plants found in Maquiling National Park and its vicinity. December, 1937.
15. Prof. A. P. Racelis. The use of probable error in forestry research. February, 1938.
16. Mr. M. Sulit, Dr. J. Marañon, and Miss L. Cosme. Cultural and chemical studies of Derris grown in the Bureau of Forestry Nursery, Los Baños, Laguna. March, 1938.
17. Prof. C. Mabesa. The relation of green weight of bark of bakawan and pototan to their wood volume. July, 1938.
18. Dr. F. M. Salvoza. The dipterocarps in the U. P. Land Grant, Basilan Island. August, 1938.
19. Mr. J. Seguerra. Timber mining versus sustained yield in the U. P. Land Grant, Basilan, Zamboanga. December, 1938.
20. Prof. E. F. Roldan and Mr. S. A. Madarang. Cinchona disease situation in Bukidnon. February, 1940.

GUEST FOREIGN SPECIALISTS

One of the established policies of the Club is to invite to address the members, whenever an opportunity arises, specialists who come to the Philippines either as transients or as visitors. The specialists who have spoken before the Club since 1933 are as follows:

June 26, 1934: Dr. C. E. McClung, Professor of Zoology and Director of Zoological Laboratories, University of Pennsylvania.

Subject of address: *Cytological studies on locusts.*

August 30, 1934: Dr. Ira Condit, Professor of Pomology, University of California.

Subject of address: *History and development of the common fig of commerce.*

July 25, 1935: Mr. Walter Jepsom, Mauritius Sugar Cane Experiment Station.

Subject of address: *Mauritius and its sugar cane problem.*

January 27, 1938: Dr. Tyôzaburô Tanaka, Professor of Horticulture, Taihoku Imperial University.

Subject of address: *Achievements in horticultural research in Japan.*

February 13, 1940: Professor Edward A. White, Head, Department of Floriculture and Ornamental Horticulture, Cornell University, Emeritus.

Subject of address: *Orchid culture.*

LITERATURE CITED

ANON. 1925. Note: The Los Baños Biological Club. The Philippine Agriculturist 14: 189–190.

FRONDA, F. M. 1927. Note: Los Baños Biological Club. The Philippine Agriculturist 16: 49–51.

MANRESA, MIGUEL. 1934. Note: The Los Baños Biological Club: Ten years of active work in research. The Philippine Agriculturist 22: 607–624.

JOSÉ M. CAPINPIN
Of the Department of Agricultural Botany

TABLE 1

List of officers, number of scientific meetings held, and number of papers read in each term during the period from December, 1923, to March, 1940

PRESIDENT	SECRETARY	TERM	SCIENTIFIC MEETINGS	NUMBER OF PAPERS
Dr. B. M. Gonzalez	Dr. L. B. Uichanco	1923–1925	1st–10th	28
Dr. N. B. Mendiola	Dr. M. Manresa Dr. Marcos Tubangui	1925–1926	11th–19th	27
Dr. L. B. Uichanco	Dr. A. K. Gomez	1926–1927	20th–26th	19
Dr. A. K. Gomez	Dr. F. M. Fronda	1927–1928	27th–34th	23
Dr. R. B. Espino	Dr. V. Villegas	1928–1929	35th–43rd	25
Dr. F. O. Santos	Dr. G. O. Ocfemia	1929–1930	44th–52nd	22
Dr. V. Villegas	Prof. Carlos Sulit	1930–1931	53rd–61st	22
Dr. G. O. Ocfemia	Dr. Z. de Jesus	1931–1932	62nd–71st	24
Dr. F. M. Fronda	Prof. A. de Mesa	1932–1933	72nd–82nd	25
Dr. M. Manresa	Dr. Lope M. Yutuc Prof. P. Dacanay	1933–1934	83rd–91st	23
Prof. P. Dacanay	Dr. L. G. Gonzalez	1934–1935	92nd–102nd	29
Dr. A. L. Teodoro	Mr. Ricardo Buhay	1935–1936	103rd–111th	23
Dr. L. G. Gonzalez	Mr. E. F. Roldan	1936–1937	112th–120th	23
Dr. I. Aquino	Prof. Valentin Sajor Mr. Justino Seguerra	1937–1938	121st–130th	22
Dr. J. B. Juliano	Dr. J. M. Capinpin	1938–1939	131st–140th	26
Dr. J. M. Capinpin	Dr. F. M. Salvoza	1939–1940	141st–150th	23

TABLE 2

Summary of scientific papers read and discussed before the Club from December, 1923 to March, 1940

PARTAKERS	DECEMBER, 1923 TO MARCH, 1938	JUNE, 1938 TO MARCH, 1939	JUNE, 1939 TO MARCH, 1940	TOTAL
I. College of Agriculture				
1. Agricultural Botany	20	4	2	26
2. Agricultural Chemistry	41	3	3	47
3. Agricultural Economics	2	1	1	4
4. Agricultural Education	1	0	1	2
5. Agricultural Engineering	16	1	0	17
6. Agronomy	63	5	7	75
7. Animal Husbandry	58	4	4	66
8. Entomology	21	1	1	23
9. Plant Pathology	23	2	1	26
10. Soils	9	2	0	11
11. Medical Department	3	—	—	3
12. Extension Service	1	—	—	1
II. School of Forestry	31	3	2	36
III. College of Veterinary Science [a]	33	—	1	33
IV. Visiting Scientists	8	0	—	9
Total for the period [b]	330	26	23	379

[a] Transferred to Manila, June, 1933.
[b] Five unclassified papers may be added.

COLLEGE AND ALUMNI NOTES

The following papers were read and discussed at the regular meeting of Los Baños Biological Club on February 29, 1940.

Mr. Francisco Barros. A comparative study of the effects on the yield of corn of some leguminous crops used as green manure.

Prof. E. F. Roldan and Mr. S. A. Madarang. Cinchona disease situation in Bukidnon.

Dr. A. I. de Leon and Mr. R. Samaniego. Activated carbon from agricultural waste products.

The following papers were reported before the regular meeting of the club on March 14, 1940:

Dr. V. C. Calma and Mr. J. P. Tiangsing. The comparative effects of soybean and peanut planted with sugar cane and ammonium sulfate fertilizer upon the yield of sugar cane.

Mr. J. Seguerra. The establishment of sample plots.

The traditional luncheon in honor of this year's graduating class was given by Dean L. B. Uichanco at the Molawin Hall on Monday, March 25.

The U. P. Rural High School held its ninth commencement exercises on March 30, 1940. Dean Francisco Benitez of the College of Education was the speaker. He was introduced by Dean L. B. Uichanco.

Dean L. B. Uichanco was the commencement speaker at the graduation exercises of the Laguna Institute at Calamba, Laguna on March 25, 1940.

Dr. Francisco M. Sacay, Acting Head of the Department of Agricultural Education, topped the list of successful examinees for superintendent of agricultural instruction given by the Bureau of Civil Service.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS

Circular No. 2.—Bud Rot of Coconut (Revised. June. 1934) - - - *By G. O. Ocfemia*

Circular No. 3.—Experimental Errors and Application of the Probable Error to and the Interpretation of Experimental Results - - - - - - - - - - - - - *By Nemesio B. Mendiola* (Published as Chapter IV in *A Manual of Plant Breeding for the Tropics*, 1926, also sold by THE PHILIPPINE AGRICULTURIST at ₱3.25, paper bound, and ₱5.25, cloth bound, in the Philippines, and ₱3.50 and ₱5.50 elsewhere, postpaid.)

Circular No. 5.—Poultry Raising Made Easy (Revised) - - - - *By F. M. Fronda*

Circular No. 7.—How to Produce New Varieties of Gumamela (Hibiscus) - - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 8.—Horse Breeding in the Philippines - - - - - *By Valente Villegas*

Circular No. 9.—Fences for Farm Animals - *By B. M. Gonzalez and J. P. Esguerra*

Circular No. 10.—Practical Directions for Coffee Planting - - - *By Pedro A. David*

Circular No. 11.—The New College Copra Drier—Prepared in *Department of Agricultural Chemistry* with cooperation of *Department of Agronomy and Extension.* (Revised by *Moises M. Kalaw*).

Circular No. 14.—Beriberi: Its Causes and Prevention - - - - - *By F. O. Santos*

Circular No. 15.—Cattle Raising under Philippine Conditions - - *By Valente Villegas*

Circular No. 16.—A Simple Farm Record for the Farmer - - *By Francisco M. Sacay*

Circular No. 17.—College Trapnest - - - - - - - *By F. M. Fronda and P. S. Paje*

Circular No. 18.—Surveying for Area with a Surveyor's Staff - *By Alexander Gordon*

Circular No. 19.—A Pageant: Illustrating the History and Growth of the College of Agriculture - - - - - - - - *By Anne F. Cole*

Circular No. 20.—Amount of Nutrients in Philippine Food Materials - - - - - - - - - *By F. O. Santos and S. J. Ascalon*

Circular No. 21.—Cassava Growing and Cassava Starch Manufacture - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 22.—Goat Raising - - - - - - - - - - - - - - - *By Valente Villegas*

Circular No. 23.—Curing Pork and Making Sausage for Home Use - - - - - - - - - - - - - - - - *By Mariano Mondoñedo*

Circular No. 24.—Construction and Operation of Silos in the College of Agriculture - - - - - - - - - - - - *By José P. Esguerra*

Circular No. 26.—Training Cattle and Carabaos for Work - - - *By Valente Villegas*

Circular No. 27.—Bunchy-top of Abacá - - - - - - - - - - - - *By G. O. Ocfemia*

Circular No. 28.—Cotton Culture - - - - - - - - - - - - *By Eulalio P. Baltazar*

Circular No. 29.—Collegiate Education in Agriculture - - - - *By L. B. Uichanco*

Circular No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? - - - - - - - - - - *By N. B. Mendiola*

Circular No. 31.—How to Slaughter and Dress Farm Animals - - - - - - - *By Valente Villegas and M. Mondoñedo*

The Circulars Nos. 1, 3, 4, 6, 12, 13, and 25 are out of print.

The price of the Circulars listed above is 10 centavos each except Nos. 5, 10, 16, 21, and 30 the price of which is 20 centavos.

ALL ORDERS SHOULD BE ADDRESSED TO THE BUSINESS MANAGER, THE PHILIPPINE AGRICULTURIST, AGRICULTURAL COLLEGE, LAGUNA, PHILIPPINES